

STUDIA GEOBOTANICA

An international journal

Vol. 12 1992

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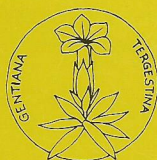
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**Dipartimento di Biologia
Sezione di Geobotanica ed Ecologia vegetale**

Università di Trieste

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STUDIA GEOBOTANICA publishes original articles in the field of geobotany. It also publishes reviews of published works, short communications, notices of scientific meetings and summaries of proceedings.

MANUSCRIPTS should be submitted in triplicate including tables and figures to the Secretary of the Editorial Board. The Secretary will confirm receipt of the manuscript. The suitability of submitted manuscripts will be judged by appropriate members of the Editorial Board. Appropriate referees will be consulted. The Secretary will inform authors of the acceptance or rejection of manuscripts or the need for substantial revisions or reduction. Manuscript should be typed, double-spaced, on white bond paper A4 format with 35 mm margin on all side. All pages should be numbered. Send also one copy on 3.5" disk based on Microsoft Word5.5 program.

LANGUAGE should be preferably English. Italian, German, Spanish and French are also accepted.

THE TITLE should be informative and brief. The name(s) (given name-surname) of the author(s) should be placed below the title. References to research projects, institutional publication numbers, etc. should be placed in a footnote in the first page.

KEYWORDS, no more than 10, in English, should be placed on the title page in alphabetical order.

ABSTRACT. An English abstract must be included. For non English text, the abstract must include the title. A summary in a second language may also be added; it should not exceed one manuscript page.

MAIN TEXT should be clearly divided into sections. Chapter headings should be given without designations. New paragraphs should be indicated by indentation. Footnotes should be avoided. Appendices should be placed at the end of the main text.

ACKNOWLEDGEMENTS and dedications should be simply phrased and given before the references.

REFERENCES to articles and books should be limited to published works. Citation of references in the text: Dolcher & Pignatti (1971) or (Fukarek 1977; Clotet *et al.* 1988; Podani & Borhidi 1989). Citation of references:

Malyshev L.I., 1991. Some quantitative approaches to problems of comparative floristics. In: Nimis P.L. & Crovello T.J. (eds.), Quantitative approaches to phytogeography. Kluwer Academic Publishers, Dordrecht, Boston, London, 15-33.

Poelt J., 1969. Bestimmungsschlüssel europäischer Flechten. J. Cramer, Vaduz, 757 pp.

Trevisan R., Cappelletti E.M. & Caniato P., 1983. Epicarp micro-characters in some european *Angelica* species. Atti Accad. Naz. Lincei, Rend. Cl. Sci. fis., mat. e nat., 74: 77-82.

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Prof. Duilio Lausi

The Editorial Board of *Studia Geobotanica* is glad to dedicate this volume to Prof. Duilio Lausi, on the occasion of his 70th birthday.

Prof. Lausi was born in Trieste on July, 14, 1923; since his earliest years he showed a keen interest in botany, starting to assemble a large herbarium of plants collected in the surroundings of Trieste. Strangely enough for a botanist, in 1956 he got a degree in Economy, a fact that probably influenced his tendency towards a numerical approach to the study of plant communities. In 1960, year of its foundation, he contacted the Botanical Institute of the University of Trieste, and was convinced by his director, prof. S. Pignatti, to operate full-time in the field of botany. He entered the Institute as a technician, but made a rapid career, starting to teach Botany in 1964, Plant Ecology in 1967, and becoming associate professor in 1970. In 1973 he was nominated full professor of Botany, a position which he held until the present day, besides other temporary charges, such as that of Director of the Institute and Dean of the Biology Faculty.

Prof. Lausi is the author of 75 articles in different fields of Botany: chemosystematic researches on critical taxa of the Italian flora, pioneering studies on photosynthesis and primary productivity of marine ecosystems, development of quantitative methods for the analysis of the vegetation and for its ecological and phytogeographical study. Among his most important contributions to science are a fundamental study of the phenological rhythms of European beech forests, the quantitative evaluation of photosynthetic pigments in Mediterranean phytoplankton, a numerical synthesis of European halophytic vegetation, the studies on convergent evolution in plant communities and on the phytogeography and ecology of the Yukon Territory. Notwithstanding the variety of subjects, the scientific production of Prof. Lausi appears as an organic whole, the "golden thread" binding the different topics being his peculiar methodological approach, based on the application of a cogent and strict logic, and of numerical methods of data analysis. Prof. Lausi was one of the pioneers in the application of computer techniques in vegetation science, although he never forgot to teach his students that before using numerical methods one should be well-acquainted with biological problems, and that such techniques may be a great help for biologists, but should not be considered as an aim in itself. Besides his scientific interests, the amicable personality of Prof. Lausi, and his profound culture, were a source of pleasure and enrichment for all his co-workers, colleagues and friends. As "Professor Emeritus" he will have the opportunity to pursue his activity at Trieste, and he will certainly do this with the same extraordinary energy and intensity as he did in the past.

Prof. Lausi has followed the development of *Studia Geobotanica* since its foundation in 1980; as Editor-in-chief of the Journal, he not only curated its editorial policy, but, as usual for him, also went into such details as to follow the printing process up to the last stages; this forced us, for inserting this dedication, to add two pages without numeration at the last moment, in order to avoid being "discovered" by the keen eye of the director...

For the Editorial Board

Pier Luigi Nimis

LICHENOLOGICAL STUDIES IN NE - ITALY. V: NEW RECORDS FROM FRIULI - VENEZIA GIULIA

Mauro TRETIACH

Keywords: Alps, Flora, Friuli-Venezia Giulia, Italy, Karst, Lichens.

Abstract: this paper reports *ca.* 800 lichen records from Friuli - Venezia Giulia. 8 species (*Cladonia diversa*, *Fellhanera subtilis*, *Lecanora cinereofusca*, *L. impudens*, *Poeltinula cacuminum*, *Polyblastia helvetica*, *Scoliciosporum pruinosum* and *Trapelia placodioides*) are new to Italy. 211 species are reported for the first time from Friuli, and 48 from the Karst. The samples are preserved in the TSB herbarium.

Introduction

Friuli -Venezia Giulia region was for a long time the lichenologically least known region of northern Italy. The first important lichenological collection was that of B. Biasoletto (1793-1858), a pharmacist who collected phanerogams, algae, mosses and lichens mainly in the Karst region and in Istria, and who was in contact with the most eminent botanists of his time; his important collections are now preserved in the Civic Museum of Natural History of Trieste (TSM) and were never published. Some years later M. De Tommasini (1794-1879) formed a larger herbarium of cryptogams and phanerogams with the assistance of several collectors; the lichens (many collected in areas presently in Slovenian territory) were identified by J. Glowacki (1846-1915), who, in 1874, published the main lichenological contribution for this area in the previous century, where more than 200 taxa are cited. The lichen herbarium of De Tommasini is divided between TSM and the Natural History Museum of Graz (GJU). At the end of the century some lichen collections from the Trieste territory were assembled by J. Schuler (1853-1945), a teacher of natural sciences first at Trieste and later, for a long time, at Fiume; Schuler (1893) published a short note listing 39 species from the surroundings of Trieste; the material was partly identified by A. Zahlbruckner. A few further records from the Karst are included in his interesting Lichen Flora of Fiume (Schuler 1902), a town presently in Croatian territory. The herbarium of Schuler is preserved at the University of Padova (PAD, see Caniglia & Andreose 1990). The lichenological exploration of the Trieste territory ceased almost completely in the first half of this century. A few

This study has been financed by M.U.R.S.T. funds, responsible Prof. P.L. Nimis.

records are contained into monographs of different genera, and mostly refer to duplicates of the herbarium Glowacki, preserved in Uppsala.

The first lichen records from Friuli were given by Suffren (1902), who listed only a few, rather uninteresting species. Further additions are found in scarce records scattered in the papers of A. Massalongo, and in a few specimens distributed by V. Trevisan in his "*Lichenotheca Veneta*". In the second half of the last century some small lichen collections, now preserved in MFU, were assembled by G. A. Pirona (1822-1895) and A. Morassi (1809-1863); a small lichen herbarium by G. Fornaciari (1907-1991) is also deposited at MFU. Most of these collections have been never published (see Tretiach 1990). In the first half of this century Friuli remained virtually unexplored by lichenologists, with the exception of a few, rather irrelevant records contained in the flora of Jatta (1909-11) and in some papers of Cengia-Sambo.

A more systematic study of the lichen flora of the whole region started in the last ten years, mostly by researchers of the University of Trieste. Several lichenological papers have been published, among which the floristic lists of Nimis & Loi (1982, 1983, 1984) Clerc (1983), Castello & al. (1991), the vegetational studies by Nimis & De Faveri (1981) and Nimis (1981, 1982b), a phytogeographical study on the lichens of the Karst (Nimis & Losi, 1984) and two papers on the epiphytic lichens of the towns of Trieste (Nimis 1985a) and Udine (Nimis 1986). A few lichens are also reported by Codogno & al. (1985) from the Julian Alps. Finally, Tretiach & Nimis (1988) studied the distribution of *Normandina pulchella* within the Region (with a distribution map).

During numerous field studies carried out in the Friuli-Venezia Giulia region, the researchers of the University of Trieste collected several thousands specimens, now preserved in the Herbarium Universitatis Tergestinae (TSB, Herb. P.L. Nimis). Many of these specimens belong to species not previously reported from this region. The most interesting records are listed in this work, as a further contribution to the knowledge of the lichen floristics of the region.

Survey area

The survey area corresponds with the administrative region of Friuli - Venezia Giulia, and to the orographic left bank of the Piave Valley. This area has been divided in six geographically homogeneous districts: Carnic Alps, Julian Alps, Carnic pre-Alps, Julian pre-Alps, Friulian Plain and Karst (Fig. 1). In the following, a brief description of their main features are given.

Carnic Alps: The main substrata are calcareous and dolomitic rocks, with the exception of the inner Carnic Alps, where a wide variety of siliceous rocks occurs. The elevation ranges from ca. 300 to 2780 m (M. Coglians); the vegetation varies from broad-leaved woods to alpine meadows, particularly well-developed on acid soils; natural spruce stands are rare due to the suboceanic climate.

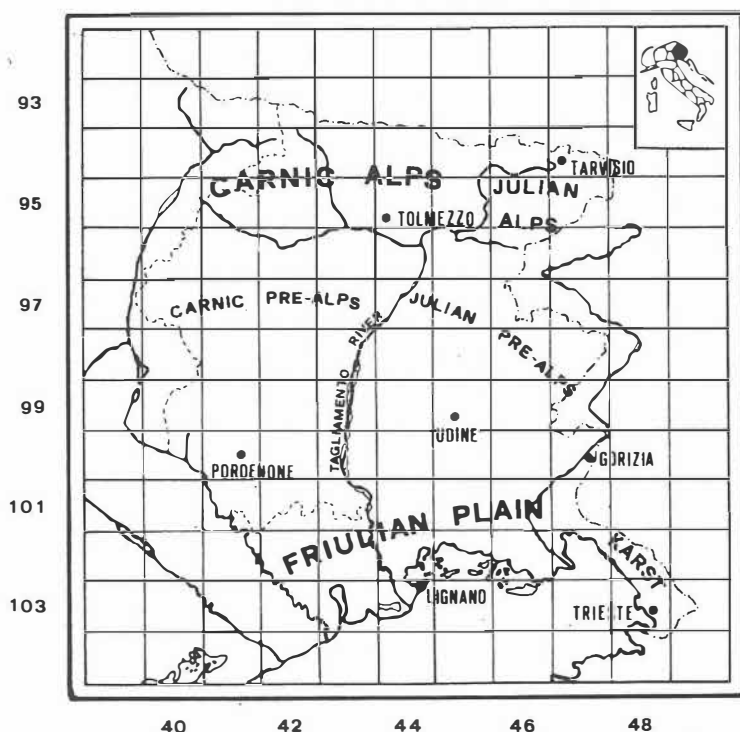


Fig. 1.- Map of the Friuli - Venezia Giulia region, with the subdivision in basic areas according to the Project of Floristic Cartography of Central Europe.

Carnic pre-Alps: this district is formed by calcareous mountains (max. elevation: 2703 m, Cima dei Preti), which host extensive beech woods; in the inner district, open *Pinus sylvestris* stands are frequent on the dry, south exposed sides of the valleys. The human impact in this district is very low.

Friulian plain: this is the largest district of the region and hosts more than 60 % of the total population. The climax vegetation, formed by *Carpinus* and *Quercus* woodlands, has been almost completely destroyed, and survives only in small fragments in protected areas. Agriculture is particularly well-developed, and industrial areas are scattered throughout the district.

Julian Alps: The main substrata are calcareous rocks, except in the area of M. Mangart (dolomitic rocks), and small outcrops of porphyric rocks. The elevation ranges from 300 to 2753 m (Jôf di Montasio). The vegetation of this district is similar to that of the Carnic Alps, but in the area of the Fusine Lakes, characterized by a rather continental climate, well-developed, typical spruce forests are present.

Julian pre-Alps: also this district is mainly occupied by calcareous mountains (max. elevation: 1959 m, M. Pláuris), and by eocenic hills, consisting of more or less calciferous sandstone. In the Julian pre-Alps there are the highest precipitations of Italy, with an average of more than 3000 mm of rainfall per year (M. Musi, see Gentili, 1964). The forest vegetation is formed by mixed oak woods in the lowlands, hygrophytic woods of *Fraxinus excelsior*, *Ostrya carpinifolia* and *Tilia*, and beech forest in the montane belt. The human impact is rather low.

Karst: this district has a small extension and a rather narrow altitudinal range, from sea level to ca. 450 m; it corresponds almost completely to the Province of Trieste; a small portion belongs to Slovenia and to the Province of Gorizia. The Karst Region is characterized by impressive karstic phenomena and hosts a peculiar, mainly eastern flora. Young woods of *Ostrya carpinifolia* and *Quercus pubescens* cover the Karst plateau, intermingled with *Pinus nigra* plantations; small fragments of Mediterranean maquis, with *Quercus ilex* and *Phillyrea latifolia*, are present along the calcareous coasts. A narrow, discontinuous belt of sandstone is present in the coastal area. Rainfall is around 1200 mm per year.

Data and Methods

The following floristic list is based on ca. 800 samples preserved in the Herbarium Universitatis Tergestinae (TSB), Herb. P.L. Nimis. For each species, a brief comment on its ecology, distribution and taxonomy is reported, and for each sample the locality, altitude, substratum, date of collection, collector name (abbreviations as follows: N, Nimis; T, Trevisan) and data bank number are given. Different symbols are used for records new to the Karst (), to Friuli () or to Italy (). The nomenclature follows Nimis (1993).

Floristic list

***Acarospora badiofusca* (Nyl.) Th. Fr.**

Carnic Alps: - M. Tenchia (UD), 1950 m, on siliceous rock, 26.06.1988, leg. Bersan (12813). - M. Crostis (UD), 1850 m, on sandstone, 08.1986, leg. N & T (9955). - Lateis (UD), above C.ra Novarzutta, c. 1730 m, on sandstone, 28.09.1988, leg. N & T (10944).

A widespread circumboreal species, which is known only from a few localities in the Italian Alps (South Tyrol, Lombardy), and the northern Apennines, and from Sardinia. It is fairly common in the Carnic Alps, on sandstone; some specimens can be included in the ssp. *badiorubra* Clauz. & Roux, differing in having brownish apothecia.

Acarospora fuscata (Nyl.) Arnold

Carnic Alps: - M. Tenchia (UD), 1950 m, on siliceous rock, 26.06.1989, leg. Bersan (12814).

Karst: - M. Radio, 130 m, on sandstone, 15.06.1985, leg. N (5780).

A widespread silicicolous species, which is locally common throughout Italy, but was not previously recorded from Friuli. Glowacki (1874) already reported it from the Karst area.

Acarospora gallica Magnusson

Karst: - Between S. Croce and Filtri di Aurisina (TS), on sandstone, c. 30 m, 06.1988, leg. T (10536). - Trieste, M. Valerio, on sandstone, c. 150 m, 11.11.1982, leg. N (2902).

This species has been reported from scattered localities throughout central Europe, and is also known from Macaronesia. It occurs on base-rich or calciferous siliceous rocks, often also on walls. It seems to be fairly frequent on sandstone walls near Trieste.

Acarospora macrospora (Hepp) Bagl.

Carnic Alps: - Casera Razzo (BL), 1750 m, on limestone, 06.08.1986, leg. N (7785). - Passo Pramollo, 1600 m, on limestone, 25.11.1983, leg. Palma (3831).

A species with a holarctic distribution, occurring on steeply inclined surfaces of calcareous rocks. It is known from several stations throughout Italy, but it was not previously recorded from Friuli.

Acarospora modenensis Magnusson

Karst: - Between S. Croce and Filtri di Aurisina (TS), 3 m, on sandstone, south exp., 06.1988, leg. T (10529).

The type material of this rather poorly-known, but well-distinguished species, is on sandstone. For Italy this lichen was only known from Emilia, Liguria and Sardinia. Our specimen is well-developed, and was collected on decalcified sandstone, near the seashore; it corresponds well with the description, and with several collections from Sardinia (TSB).

Acarospora murorum Massal.

Karst: - Contovello (TS), c. 180 m, on sandstone, south-east exp., near the ground, 01.01.1989, leg. T (10950).

Clauzade & Roux (1985) consider this taxon as a subspecies of *A. macrospora*; it has a mainly submediterranean distribution, and it often occurs on walls; owing to the very different ecology and distribution I prefer to maintain it at species rank. It is not common near Trieste, on sandstone walls.

Acrocordia cavata (Ach.) R.C. Harris

Julian pre-Alps: - Valli del Natisone, Stregna (UD), on *Juglans*, c. 500- 600 m, 08.1981, leg. N, rev. T (2754).

A. cavata has been certainly overlooked in the survey area, as elsewhere; for Italy it was known only from Sardinia and Calabria; it might have been confused

with the similar *A. gemmata*, differing in the larger spores and the bigger perithecia.

***Acrocordia conoidea* f. *carnea* Arnold**

Karst: - Gropada (Basovizza, TS), c. 360 m, on limestone, in a doline, 17.11.1992, leg. T (16646). - Gropada (TS), c. 380 m, on limestone, in a doline, 15.01.1993, leg. T (16652).

This form of *Acrocordia conoidea* is characterized by more or less immersed, light pink perithecia, and an endolithic, whitish thallus; these characters allow an easy distinction from *A. conoidea* s. str. (see Keissler 1937). Typical, black perithecia are intermingled with pink perithecia in a small fragment of the sample 16652. A careful anatomical examination showed that the perithecia in the f. *carnea* have the same structure of the lower part of the perithecia in the f. *typica*, suggesting that the former lacks the black pigments; moreover, the two forms cannot be distinguished on the basis of spore or ascoma dimensions. *A. conoidea* f. *carnea* has been collected only twice, on hard limestone, in exposed positions, but probably it is more frequent.

***Acrocordia gemmata* (Ach.) Massal.**

Julian Alps: - Laghi di Fusine (UD), on *Abies alba*, 960 m, 30.09.1986, leg. N (7907). *Julian pre-Alps*: - Val di Resia, Borgo Lischiazze (UD), on *Fraxinus excelsior*, 550 m, 27.09.1987, leg. N & T.

Karst: - Gropada (TS), on *Q. pubescens*, c. 400 m, 06.03.1990, leg. T (13726). - Dolina di Percedol (TS), epiphytic (*Fraxinus*?), 01.03.1983, leg. Loi & N (3260). - Aurisina (TS), on *Q. pubescens*, c. 200 m, 05.03.1987, leg. N & T (8383). - Slivia (TS), near the large dolina towards Visogliano, on *Quercus*, 06.1991, leg. T (15975).

This widespread species is rather common in the inner part of the Karst plateau, growing mainly on the bark of ancient *Quercus petraea*, and is often associated with *Bacidia rubella*. It is new to Friuli.

***Agonomia tristicula* (Nyl.) Zahlbr.**

Carnic Alps: - Casera Razzo (BL), 1700 m, on epilithic mosses, 07.08.1986, leg. N, rev. T (7820).

Karst: - Bristie (Sgonico, TS), on epilithic mosses, c. 180 m, 20.01.1989, leg. T (11310).

In Italy this species is known only from South Tyrol, Sardinia, Calabria and the Karst. It grows on plant remains and mosses over calcareous substrata, much more rarely on bark at the base of the trunks. It has been certainly overlooked in the other districts of the region; the specimen from the Karst is very poorly developed.

***Alectoria nigricans* (Ach.) Nyl.**

Carnic Alps: - Passo Volaia, 2000 m, on soil, on calcareous, wind-swept ridge, 07.08.1981, leg. De Faveri & N (1970).

A circumboreal, bipolar, arctic-alpine species which is certainly much more widespread along the Italian Alps than the few records (South Tyrol, Piedmont, Aosta Valley) might suggest. New to the Carnic Alps.

Alectoria ochroleuca (Hoffm.) Massal.

Carnic Alps: - Piz di Mede, 2000 m, on soil, on wind-swept ridge, 09.08.1986, leg. N (7726). - M. Paularo, 2000 m, on soil, on wind-swept ridge, in *Loiseleurieto- Cetrarietum*, 16.08.1981, leg. N (1711). - M. Dimon, 1900 m, on soil, on wind-swept ridge, 10.08.1983, leg. N (3377). - M. Paularo, 2040 m, on soil amongst bryophytes, 28.09.1990, leg. T & Castello (14670). *Julian Alps*: M. Canin, 2000 m, on soil, on wind-swept ridge, 07.1980, leg. De Faveri & N (1353).

This species, which ecologically resembles *A. nigricans*, is certainly much more common than the latter in the Alps, and is locally abundant on wind-exposed ridges in the inner siliceous Carnic Alps.

Amandinea punctata (Hoffm.) Coppins & Scheidegger ad int.

Karst: - Rupingrande, 400 m, on *Ulmus*, 25.10.1982, leg. N (2839).

This is a common, and probably non-homogeneous species with a broad ecological range, which was not previously reported from the survey area.

Arthonia cinereopruinosa Schaerer

Carnic Alps: - Lago di Sauris (UD), Bosco Flobia, c. 1040 m, at the base of *Abies alba*, 28.09.1988, leg. N (10863).

This epiphytic species has probably a holarctic distribution; it is not common in Europe, but it was recorded from Scandinavia to the Mediterranean mountains. Our collection is from a very humid forest. The species is new to Friuli, where it is certainly very rare.

Arthonia cinnabarina (DC.) Wallr.

Carnic pre-Alps: - Forra di Battei (PN), epiphytic, 1982, leg. Loi (3008). *Julian pre-Alps*: Debellis (UD), 350 m, on *Fraxinus excelsior*, 26.06.1985, leg. N (5867).

This epiphytic lichen has a broad total distribution. There are several records from Italy, but the species appears to be strongly declining in the north. In Friuli it is certainly very rare, and is restricted to the more humid districts of the pre-Alps, mostly in gorges and near rivers at low altitudes.

Arthonia exilis (Flörke) Anzi

Julian Alps: - Valbruna (UD), 1000 m, on bark, 20.11.1982, leg. N (2919). - Valle del Fella, near Valbruna (UD), 1000 m, on *Sambucus*, 20.11.1982, leg. N (5181).

A chiefly central European epiphytic species, also known from North America, which in Italy has been recorded from the central and eastern Alps, and from Sardinia. According to Coppins (1989) the species, as currently understood, is probably heterogeneous. Our specimens are poorly-developed, and can be attributed only to *A. exilis* s. lat.

Arthonia fuliginosa (Turner & Borrer) Flotow

Carnic Alps: - Lago di Sauris, Bosco della Stua, above Rio Storto, 1040 m, on *Abies alba*, 26.09.1990, N & T (15073).

This is a rare epiphytic lichen, reported only from a few localities in central and western Europe; for Italy it was known only from South Tyrol. From the

Carnic Alps there is a very abundant collection taken in a single locality; the site, a gorge in the north-exposed side of the Lake of Sauris, is very humid, and hosts a very interesting flora with several oceanic species.

Arthonia varians (Davies) Nyl.

Carnic Alps: - M. Tenchia (UD), 1400 m, on *Lecanora rupicola*, 12.06.1988, leg. Bersan (10452).

A parasitic species, growing in the apothecia of *Lecanora rupicola* s. lat. It is common throughout Italy, especially in the mountains, but it was never recorded from Friuli.

Arthonia vinosa Leighton

Julian Alps: - Foresta di Tarvisio, near Valbruna (UD), 950 m, on bark, 20.11.1982, leg. N, rev. T (3017).

A suboceanic species known only from Europe. For Italy it has been reported from several scattered localities, from South Tyrol to Calabria.

Arthopyrenia microspila Körber

Carnic Alps: - Clendis (Ampezzo, UD), 750 m, on *Graphis scripta*, on *Fagus*, 05.09.1985, leg. N (6442). - Passo Pura, Bosco della Stua, 1100 m, on *Graphis scripta*, on *Alnus*, 11.09.1987, leg. N & T (9739).

The systematic position of this taxon is still uncertain. According to Hawksworth (1983), it should belong to *Stigmidium*, but according to Coppins (1988) it belongs to *Arthopyrenia* s.str. The spores are colourless when young, but pale brown at maturity. Also the number of septa is variable, from 1 to 3. It is a parasitic fungus which has been certainly overlooked; in TSB I have found only two samples of *Graphis scripta* with well-developed thalli of the parasite, on a total of c. 30 samples. This is the second record from Italy.

Arthroraphis citrinella (Ach.) Poelt

Carnic Alps: - M. Tiarfin, 2200 m, on soil, 20.09.1981, leg. Loi & N (2035). - M. Tiarfin, 2100 m, on *Baeomyces*, 20.09.1981, leg. Loi & N (3036). - M. Paularo, on soil, 2040 m, 28.09.1990, leg. Castello & T, ref. W. Obermayer (15870).

A bipolar, arctic-alpine species of acid humus; it is widespread throughout the Alps, but it was not previously recorded from Friuli.

Aspicilia alphoplaca (Wahlenb.) Leuckert & Poelt

Carnic Alps: - Lateis (UD), above C.ra Novarzutta, c. 1730 m, on sandstone, 28.09.1988, leg. N & T (10856). - M. Novarza (UD), 1500 m, on sandstone, 09.1989, leg. N (14118).

A species with a very wide, disjunct distribution in several continents, occurring on base-rich siliceous rocks. It is widespread throughout the Alps and in the Mediterranean mountains. New to Friuli.

Aspicilia caesiocinerea (Nyl. ex Malbr.) Arnold

Carnic Alps: - M. Pieltinis, 1600 m, on sandstone, 08.1981, leg. N (2251). - Lateis (UD), C.ra Novarzutta, c. 1730 m, on sandstone, 28.09.1988, leg. T (10889). - M. Novarza, 1870 m, on sandstone,

11.09.1984, leg. N (4498). - Passo di M. Croce Carnico, 1300 m, on sandstone, leg. N (2879). - M. Novarza, 1700 m, on sandstone, 11.09.1984, leg. N (4555).

This species belongs to a complex of several closely related taxa, which is still in need of a revision. *A. caesiocinerea* s.lat. is common throughout Italy, both in the lowlands of the south and in the Alps; the identity of the lowland populations with the Alpine ones is uncertain.

***Aspicilia intermutans* (Nyl.) Arnold**

Karst: - Contovello (TS), 230 m, on sandstone, 18.05.1988, leg. T (10936). - Contovello (TS), on sandstone, c. 160 m, 26.12.1988, leg. T (10967).

This is *A. intermutans* in the sense of Esnault (1985); it is common especially in Mediterranean Italy; it is very rare in the Trieste Province, where it was collected only on south-exposed sandstone rocks with a decalcified surface, near the coast.

***Aspicilia moenium* (Vainio) Thor et Timdal**

Carnic Alps: - Passo Pura (UD), 1420 m, on cement wall, 07.1988, leg. N & Timdal (10560).

This species has been certainly overlooked due to its poorly-developed thallus; it seems to prefer cement walls, in poorly-eutrophicated sites. New to Italy.

***Aspicilia parasitica* B. de Lesd.**

Carnic Alps: - M. Paularo, near the lake, parasitic on *Caloplaca chlorina*, on siliceous rock, c. 1900 m, 29.09.1990, leg. T (15416).

The distinction of this taxon from *A. radiosa* has been questioned by some authors (e.g. Clauzade & Roux 1985). I think that its chemistry and the parasitic habit could justify a separation at species rank. The identification is not certain, due to the small dimensions of the specimen, which, however, agrees well with abundant collections from Sardinia. New to Friuli.

***Bacidia arceutina* (Ach.) Arnold**

Friulian Plain: - Tarcento (UD), 300 m, on *Carpinus*, 10.1978, leg. N (2900). - Tarcento (UD), 300 m, on *Fraxinus ornus*, 26.12.1982, leg. N (3101).

A central European-submediterranean, perhaps rather suboceanic species occurring on subneutral, mostly smooth bark. It is known from a few localities throughout Italy and is new to Friuli.

***Bacidia bagliettoana* (Massal. & de Not.) Jatta**

Carnic Alps: - Passo Volaja, near the refuge, 1950 m, on mosses and plant remains, on calcareous substratum, 19.01.1990, leg. Bersan (14081). - M. Paularo (UD), 1900 m, on mosses, 10.08.1983, leg. N (3370). *Julian Alps*: - Upland between M. Cergnala and M. Lopa, c. 2100 m, on mosses, 26.09.1982, leg. Gerdol (3111).

A widespread species, from the boreal zone to the Mediterranean mountains, which is frequent in the alpine belt, on epilithic mosses and plant remains. New to Friuli.

Bacidia beckhausii Körber

Carnic Alps: - Passo Pura (UD), 1440, on *Fagus*, 09.08.1981, leg. N, rev. T (1800).

An epiphytic species occurring in humid woodlands, reported from several Italian region. New to the eastern Alps.

Bacidia friesiana (Hepp) Körber

Friulian Plain: - Tarcento (UD), 300 m, on *Sambucus*, 26.12.1982, leg. N (3093). - Faedis (UD), 200 m, on *Sambucus*, 04.1979, leg. N (3096). *Julian pre-Alps*: - Valli del Natisone, Cepletischis, 700 m, on *Sambucus*, 28.12.1982, leg. 28.12.1092, leg. N (3053).

A species of eutrophic bark, which seems to be rather frequent in the lowlands and hills of Friuli, especially on *Sambucus*. New to the survey area.

Bacidia herbarum (Stizenb.) Arnold

Carnic Alps: - M. Tiarfin, 2100 m, on mosses, 20.09.1981, leg. Loi & N (2010).

A mainly boreal-montane species occurring also in the Mediterranean mountains, growing on plant remains. There are a few earlier records from the Italian Alps, and from Tuscany. New to Friuli.

Bacidia laurocerasi (Duby) Vainio

Carnic Alps: - Lago di Sauris (UD), Bosco della Stua, 1100 m, 15.09.1985, leg. N (6460). *Friulian Plain*: - Usago (PN), 300 m, on *Fraxinus*, 02.1985, leg. Loi (5330). - Zomeais (Tarcento, UD), on *Carpinus*, 26.12.1983, leg. N (3890). - Tarcento (UD), 300 m, on *Fraxinus ornus*, 26.12.1982, leg. N (3098).

This epiphytic species has an almost worldwide distribution in humid regions. It is certainly rare in Italy, especially in the north, and is not common in Friuli, from the hills to the montane belt. Some of our samples have a K + violet epithecium.

Bacidia naegelii (Hepp) Zahlbr.

Friulian Plain: - S. Vito al Tagliamento, 30 m, on *Populus*, 18.06.1986, leg. Loi (7535). - Udine, S. Gottardo, on *Populus*, 11.01.1983, leg. N (3079). - Felleto Umberto (UD), 120 m, on *Populus*, 11.01.1983, leg. N (3076).

A widespread species of eutrophic bark, known from several localities throughout Italy, but never previously recorded from Friuli. It is easily distinguished in the field for the lighter-coloured apothecial margin.

Bacidia subincompta (Nyl.) Arnold

Carnic Alps: Passo Pura (UD), 1400 m, on *Fagus*, 07.1981, leg. N, rev. T (2228).

A boreal-temperate species in Europe, occurring on bark in humid situations and characterized a granular thallus and bacilliform ascospores. It is certainly very rare in the survey area, where it grows on trunks of mature trees; this is the only recent record from northern Italy.

Bacidia trachona (Ach.) Lettau

Friulian Plain: - Usago (PN), 300 m, on limestone, 02.1985, leg. Loi. *Carnic pre-Alps*: - Travesio (PN), 250 m, on shaded calcareous rocks, 29.11.1984, leg. Loi (4990).

A species of calciferous rocks in shaded and humid situations; for Italy it was hitherto known from South Tyrol, the Karst (Glowacki 1874), Sardinia, Campania and Sicily. New to Friuli.

Baeomyces placophyllus Ach.

Carnic Alps: - M. Paularo (UD), terricolous, c. 1950 m, 28.09.1990, leg. T (14771).

This is a circumboreal species of acid soil, hitherto known, for Italy, only from the central Alps. In the Carnic Alps it is very rare in Alpine meadows on acidic soils, mainly occurring in small carpets of *Juncus trifidus*.

Baeomyces rufus (Hudson) Rebert.

Carnic Alps: - High Pesarina valley, near the bridge, on sandstone, 24.08.1987, leg. Bersan (9697). - Lago di Sauris, Bosco della Stua, along the road, 1250 m, 07.08.1986, leg. N (7781). - M. Tiarfin, 2100 m, on mosses and sandy soil, 09.1982, leg. N (2631). - M. Tenchia, 1800 m, on soil, 26.06.1988, leg. Bersan (10917). - M. Tiarfin, 2100 m, on soil, 20.09.1981, leg. Loi & N (2023). *Julian Alps*: - M. Florianca, 1610 m, on soil, 20.07.1991, leg. T (15240). *Julian pre-Alps*: Villanova delle Grotte, 700 m, on soil, with *Calluna*, 26.06.1985, leg. N (5861). - M. Matajur, near the Rif. Pelizzo, 1320 m, on soil, 28.12.1982, leg. N (3047). - Near Monteperta (Taipana, UD), 400 m, on soil, on acid soil, 26.06.1985, leg. N (5862).

A circumboreal species, rather common on acidic soil in the montane and subalpine belts, which grows also directly on sandstone or base-rich rocks. Many specimens have well-developed soralia and/or schizidia.

Bellemerea alpina (Sommerf.) Clauz. & Roux

Carnic Alps: - M. Crostis, 1950 m, on siliceous rock, 05.09.1982, leg. N (3586). - M. Paularo, 2000 m, on siliceous, vertical face, 10.08.1983, leg. N (3391). - M. Chiadin, 1900 m, on sandstone, 13.11.1983, leg. Palma (3804).

A species with an arctic-alpine distribution, which in Italy is restricted to the Alps. New to Friuli.

Biatora pullata Norman

Carnic Alps: - Lago di Sauris, Lateis (UD), road to C.ra Novarzutta, c. 1350 m, on *Larix*, 13.09.1991, leg. T (15374). *Julian Alps*: - M. Florianca, slope W, 1590 m, on *Larix*, 20.07.1991, leg. T (15970).

L. pullata is widespread in the boreal zone and in montane regions, growing on the bark of different conifers, but more frequently on *Larix*, in communities of the *Parmeliopsidetum ambiguae*. It has been certainly overlooked in the past, being most often sterile. This species was previously cited by Clerc (1983) from the Carnic Alps. New to the Julian Alps.

Biatorella hemisphaerica Anzi

Carnic Alps: - Passo Volaia (UD), on terricolous mosses at the base of a calcareous boulder, c. 1600 m, 28.09.1990, leg. T & Castello (14753).

A circumboreal species of calciferous substrata which, in the Alps, reaches the alpine belt. New to Friuli.

Brodoa intestiniformis (Vill.) Goward

Carnic Alps: - Piz di Mede, 1900 m, on siliceous rock, 08.1986, leg. T (9729). - Piz di Mede, 1900 m, on sandstone, 09.08.1986, leg. N (7689). - Passo Pramollo, M. Carnizza, 1620 m, on conglomeratic rock, 29.05.1989, leg. Bersan & Codogno (12337). - M. Paularo, 2000 m, on siliceous rock, 29.09.1991, leg. T (15939). - M. Paularo, 2000 m, on siliceous rock, 16.08.1981, leg. N (1714). - M. Crostis, 2000 m, on siliceous rock, 05.09.1983, leg. N (3485).

This species is rather common in the Alps, from the subalpine to the alpine belt, but was not previously reported from the study area. The specimen 15939 has an upper cortex that is green-grey, not grey as usual, but the reactions of the medulla are the same as in the other specimens.

Buellia griseovirens (Sm.) Almb.

Karst: - Basovizza, 500 m, on *Fraxinus ornus*, 09.1981, leg. N (2250).

B. griseovirens is a widespread species which prefers the smooth bark of deciduous trees; certainly overlooked in the past, being almost always sterile, it is not uncommon in the survey area.

Buellia insignis (Hepp) Th. Fr.

Carnic Alps: - M. Paularo, 1800 m, on mosses, 16.08.1981, leg. N (3598). *Julian Alps*: - M. Lopa, 2300 m, on mosses, 09.08.1983, leg. N (3397).

An arctic-alpine species which grows on plant remains and mosses. The distinction towards *B. geophila* is based on the number of spore septa. In old apothecia I observed a few triseptate, deformed spores also in *B. insignis*.

Buellia erubescens Arnold

Carnic Alps: - C. re Razzo, 1700 m, on a stump, 16.09.1985, leg. N (6491). - M. Tinisa, 1700 m, on *Larix*, 07.08.1986, leg. N (7814). - Collina di Forni Avoltri, 1500 m, on *Larix*, 08.1981, leg. N (2199).

The identity of our samples seems to be unclear: our collections seem to differ in the thallus development and pigmentation, but the anatomy of the apothecia and the spore size are the same.

Calicium lenticulare Ach.

Carnic Alps: - M. Pieltinis, on marcescent coppice, in *Abieti-Fagetum*, 20.09.1981, leg. N, rev. Puntillo (5970). - High Pesarina Valley, 1100 m, on coppice, 03.09.1983, leg. N, rev. Puntillo (3682).

A rather rare species, with a scattered distribution in Europe. It grows mainly on decaying wood of conifers. Previously cited by Clerc (1984) from the surroundings of the Sauris lake.

Caloplaca adriatica (Zahlbr.) Servit

Karst: - M. Stena, 280 m, on limestone, 28.04.1985, leg. Poelt & N (5572). - M. Lanaro, 550 m, on limestone, 09.10.1985, leg. N (6555). - Lago di Doberdò, M. Castellazzo, 150 m, on limestone, south exp., 15.02.1989, leg. T (11674).

This is a characteristic species of steeply inclined, sunny calcareous surfaces of the Mediterranean and submediterranean areas of southern Europe. From

Italy it was previously reported only from Sardinia, but in the survey area it is not uncommon.

Caloplaca ammiospila (Wahlenb.) H. Olivier

Carnic Alps: - M. Brutto Passo (UD), on plant remains on soil, 1950 m, 16.09.1985, leg. N (6470). - M. Paularo (UD), on mosses on soil, 2000 m, 16.08.1981, leg. N (1717). - Passo Volaja, on plant remains, 1850 m, 08.08.1979, leg. N (819). - M. Dimon (UD), on mosses, 1900 m, 10.08.1983, leg. N (3378). - Passo Volaja, on mosses and plant remains, 1900 m, 07.08.1981, leg. N (1882).

C. ammiospila has an arctic-alpine distribution, and was rarely reported from Italy (South Tyrol, Lombardy). In the Carnic district it is rather common on plant remains and dead mosses, mainly on acidic soils in the Alpine belt.

Caloplaca arenaria (Pers.) Müll. Arg.

Carnic Alps: - M. Novarza, c. 1400 m, on sandstone, leg. T (14177).

Karst: - M. Radio, 130 m, on sandstone, 15.06.1985, leg. N (5806). - Contovello, 180 m, on sandstone, 26.12.1988, leg. T (10947). - Near Prosecco, c. 270 m, on calciferous rocks, 03.08.1991, leg. Bolognini, Castello, N & T (15313). - Near Altura, c. 250 m, on sandstone, 02.1987, leg. Palma (8060).

According to Poelt (in litt.) *C. arenaria* s.str. is limited to upland areas, and specimens collected at lower altitudes should be segregated into a different taxon. The specimens collected in the Karst area have a well-developed thallus, and could be referred to *C. spotornensis* B. de Lesd., a very poorly-known taxon itself, whose type material I have not examined.

Caloplaca areolata (Zahlbr.) Clauz.

Karst: - Val Rosandra (TS), on limestone, 160 m, 14.12.1981, leg. Loi & N (2316). - Sistiana (TS), on limestone, 230 m, 31.05.1985, leg. N (5764). - M. Grisa (TS), on limestone, 250 m, 10.06.1985, leg. N (5741). - Conconello (TS), on limestone, 280 m, 15.10.1985, leg. N (6606). - M. Stena (TS), on limestone, c. 270 m, 08.06.1988, leg. N (10624).

This is the first report of this species from Italy; the species is frequent on the top of sunny isolated calcareous boulders, in the coastal Karst area, and is mostly parasitic on other crustose lichens, mainly *Aspicilia calcarea*.

Caloplaca aurantia (Pers.) Steiner

Friulian Plain: - Maniago (PN), 280 m, on calciferous rock, 26.06.1985, leg. Loi (5931). - Lestans, on calciferous rock, 02.1984, leg. Loi (5349).

One of the most common lichens of calcareous substrata, rarely reported from Friuli.

Caloplaca aurea (Schaerer) Zahlbr.

Carnic Alps: - M. Coglians, above Rif. Marinelli, 2200 m, on calcareous soil, 13.11.1983, leg. Palma (3826). *Julian Alps*: - M. Cacciato, 2060 m, on calcareous soil, 02.08.1981, leg. Lausi (5087). - M. Canin, 1800 m, in fissures of calcareous rock, on soil, 10.08.1979, leg. N (798). - M. Lopa, in fissures of calcareous rock, on soil, 2000 m, 10.08.1981, leg. De Faveri & N (1784).

This terricolous species is widespread in the mountains of southern Europe, where it is confined to the Alpine belt. On the basis of some anatomical characters of the thallus, it could be referred to the genus *Fulgensia* (see also

Kärnefelt 1989), but the spore development is that typical of *Caloplaca* (Poelt 1965). New to Friuli.

***Caloplaca biatorina* (Massal.) Steiner**

Carnic Alps: - Passo Volaja (UD), 2000 m, on dolomite, 07.08.1981, leg. De Faveri & N (1960). *Julian Alps*: - Jof Fuart, 2500 m, on limestone, 21.08.1983, leg. Visintin (3425).

This species is generally calcicolous, and is widespread in upland areas of southern Europe. New to Friuli.

***Caloplaca cerina* v. *muscorum* (Massal.) Jatta**

Carnic Alps: - Piz di Mede, 1850 m, on epilithic mosses (calcareous sandstone), 09.08.1986, leg. N (7741).

This taxon is quite rare in the survey area, contrary to the v. *chloroleuca* (= *C. stillicidiorum*), which is fairly common on calcareous mosses in the montane district.

***Caloplaca chrysodeta* (Räsänen) Dombr.**

Carnic Alps: - Clendis (UD), 750 m, on limestone, in beech forest, 05.09.1985, leg. N (6447). *Julian pre-Alps*: M. Glemina, on limestone, 580 m, 25.09.1986, leg. N (7944). - Sorgenti del Torre near Musi, 500 m, on shaded calcareous rocks, 26.06.1985, leg. N (5842).

C. chrysodeta is distributed in the submediterranean areas of Europe. In Italy it has been reported only from Emilia, Latium and Calabria, but it is certainly more common. In the Karst it is frequent in many dolinas, on overhanging, shaded calcareous faces.

***Caloplaca cirrochroa* (Ach.) Th. Fr.**

Friulian Plain: - Ciseriis di Tarcento, 350 m, on limestone, 05.11.1982, leg. N (2998). - Toppo (PN), 230 m, on limestone, 28.05.1985, leg. Loi (5616). *Carnic pre-Alps*: Claut (PN), 700 m, on limestone, 05.1983, leg. Loi (3297). - Cimolais, 650 m, on limestone, 25.08.1985, leg. Loi (6409). *Julian pre-Alps*: - M. Matajur, 1300 m, on limestone, leg. Loi & N (1487). - M. Glemina, 800 m, on limestone, leg. De Faveri & N (1486). - Alta Val del Torre, Musi (UD), 630 m, on calcareous wall, leg. Castello, Gasparo & T (12964).

Karst: - Dolina near Borgo Grotta Gigante (TS), 300 m, on calcareous boulders, 18.03.1990, leg. N (13786). - Sistiana (TS), 100 m, on vertical calcareous face, 31.05.1985, leg. N (5684). - M. Radio (TS), 150 m, on limestone in shadow, 15.06.1985, leg. N (5779). - Val Rosandra, 200 m, on calcareous face, 03.04.1978, leg. N (565). - Redipuglia (GO), 40 m, on limestone, 07.07.1985, leg. N (5944).

This rather common species of submediterranean regions is found on half-shaded calcareous rocks. In Italy it is widespread, but it was not previously reported from Friuli.

***Caloplaca coccinea* (Müll. Arg.) Poelt**

Julian Alps: - M. Lopa (UD), on limestone, 2250 m, 10.08.1981, leg. De Faveri & N (1785). - M. Montasio (UD), on limestone, 2500 m, 08.1981, leg. N (2202).

This is an alpine species with a scattered distribution in the calcareous mountains of southern Europe (Carpathians, Balkan mountains, Alps). In Italy it

was previously known only from South Tyrol, Lombardy and Emilia; in the survey area it is certainly rather common, mainly in the subalpine belt.

Caloplaca crenularia (With.) Laundon

Carnic Alps: - M. Pieltnis, 1800 m, on sandstone 20.09.198, leg. Loi & N (2050). - Casera Razzo (BL), 1750 m, on schist, 13.07.1981, leg. Fragiaco & N (1678).

Karst: - Contovello (TS), 200 m, on sandstone, 04.1988, leg. T (10477). - M. Valerio, 130 m, on sandstone, 13.06.1985, leg. N (5772).

This taxon is certainly heterogeneous, and needs a revision. Our material corresponds well with samples from Mediterranean Italy.

Caloplaca ferrarii (Bagl.) Jatta

Carnic Alps: - Piz di Mede, c. 1800 m, on cement wall, 09.08.1986, leg. N (8329). - High Pesarina valley, 1650 m, on cement wall, 03.09.1983, leg. N (3576). - M. Crostis, 1800 m, on cement wall, 05.09.1983, leg. N (3532). *Julian pre-Alps*: - M. Bernadia, 500 m, on limestone, 26.06.1985, leg. N (5921). - Castelmonte (UD), 05.06.1981, leg. De Faveri & N (1514).

The delimitation of this taxon from *C. lactea* is not clear to me; the main differences are size of the apothecia and of the spores; it seems to prefer limestone and other calciferous substrata, but also *C. lactea* is often found in the same habitats, and the separation is not always easy.

Caloplaca flavovirescens (Wulfen) Dalla Torre & Saroth.

Carnic Alps: - Ligosullo, 1000 m, on cement wall, 16.08.1981, leg. N (1853). *Friulian Plain*: - Stella (UD), 600 m, on cement wall, 26.12.1983, leg. N (3892). *Julian pre-Alps*: - Debellis (UD), 300 m, on cement wall, 26.06.1985, leg. N (5883). - Towards Castelmonte, 600 m, on sandstone, leg. De Faveri & N (1619).

Karst: Contovello (TS), 200 m, on sandstone wall, 04.1988, leg. T (10478). - Altura, c. 100 m, on sandstone, 07.03.1988, leg. N (10100). - Prebenico (TS), 210 m, on sandstone wall, 07.10.1985, leg. N (6522). - Val Rosandra (TS), 110 m, on sandstone wall, 14.12.1981, leg. Loi & N (2299). - Ceroglie (TS), 150 m, on limestone, 16.05.1984, leg. N (4142). - Between S. Croce and Filtri di Aurisina (TS), c. 120 m, on sandstone wall, south exp., 23.05.1988, leg. T (10587).

This is a fairly common species throughout the survey area, with optimum on base-rich siliceous rocks, mainly sandstone boulders; it often occurs on walls as well. The pigmentation of the thallus is quite variable, mainly depending on the exposure to sunlight.

Caloplaca inconnexa (Nyl.) Zahlbr.

Carnic Alps: - M. Tiarfin, 1400 m, on limestone, 08.1981, leg. N (2255).

Karst: - M. Stena (TS), 270 m, on *Aspicilia radiosa*, on calcareous boulders, 08.06.1988, leg. N (10630).

This is a parasitic species, growing mainly on calcicolous crustose lichens, such as *Aspicilia calcarea*. In the Karst area it is quite common in exposed situations.

Caloplaca lactea (Massal.) Zahlbr.

Carnic Alps: - M. Tiarfin, 1500 m, on limestone, 08.1981, leg. N (2253).

An early colonizer of calcareous substrata, whose delimitation from *C. ferrarii* and *C. marmorata* is not completely clear to me.

Caloplaca lithophila Magnusson

Friulian Plain: - Tarcento (UD), 290 m, on cement wall, 12.01.1983, leg. N (3154).

Karst: - M. Valerio (TS), 110 m, on calcareous wall, 01.05.1981, leg. N (1659). - Costa dei Barbari (TS), 4 m, on calcareous boulder near the coast, 13.03.1988, leg. N & T (10127). - Monrupino (TS), 418 m, on cement wall, 26.06.1981, leg. Loi & N (1621).

This rather poorly-known species is frequent in the Karst area, mainly on eutrophiated calcareous surfaces, even on cement walls.

Caloplaca lucifuga Thor

Karst: - Precenico (Duino-Aurisina, TS), 120 m, on *Quercus* sp., 13.03.1988, leg. N & T (10143).

The scanty material was compared with more abundant collections from Sardinia and Calabria, and seems to fit well also with the original description of this recently described epiphytic species of old boles.

Caloplaca oasis (Massal.) Szat.

Karst: - Dolina di Percedol, c. 300 m, on *Verrucaria* sp., on limestone, 16.06.1992, leg. N & T (16399). - Gropada (TS), c. 380 m, on *Verrucaria* sp., on limestone, 25.12.1992, leg. T (16669).

Rather widespread in areas with a submediterranean climate, *C. oasis* forms characteristic, roundish spots on the thalli of endolithic, calcicolous *Verrucarias*. Certainly overlooked, it is new to the region.

Caloplaca ochracea (Schaerer) Flagey

Carnic pre-Alps: - Battei (PN), on limestone, 11.1981, leg. Loi (2197). *Friulian Plain*: - Paludea (PN), on limestone, 13.03.1985, leg. Loi (5448). *Julian pre-Alps*: - M. Glemina, 600 m, on limestone, 08.06.1981, leg. De Faveri & N (4195). - M. Bernadia, 550 m, on limestone, 26.06.1985, leg. N (5874).

This is a common species of submediterranean areas, which grows on limestone. Not previously reported from Friuli, where it is locally common.

Caloplaca pollinii (Massal.) Jatta

Friulian Plain: - Plessiva (GO), on *Robinia pseudacacia*, 27.12.1982, leg. N (3020).

This is a Mediterranean species which in Italy has been rarely collected in recent years. In Friuli it is not rare on isolated trees in the hills.

Caloplaca polycarpa (Massal.) Zahlbr.

Julian pre-Alps: - M. Bernadia (UD), 550 m, on limestone, 26.06.1985, leg. N (5873).

Karst: - M. Stena, 300 m, on limestone, 28.04.1985, leg. Poelt & N (5571). - M. Grisa (TS), 250 m, on *Verrucaria*, on limestone, 10.06.1985, leg. N (5742). - M. Lanaro, 550 m, on limestone, 09.10.1985, leg. N (6561).

A parasitic species, growing mainly on endolithic species of *Verrucaria*, distributed in areas with a submediterranean climate. It is common in the Karst

area, mostly within open woodlands. It was currently cited as *C. tenuatula* (Nyl.) Zahlbr.

Caloplaca sarcopidioides auct.

Eriulian Plain: - Lestans, on *Populus*, 02.1985, leg. Loi, rev. T (5353). - Bueris (UD), 250 m, on *Populus*, 10.11.1993, leg. N, rev. T (4014).

Karst: - Cernizza (Duino - Aurisina, TS), c. 10 m, on *Q. pubescens*, opening of Mediterranean maquis, 08.07.1990, leg. T (14269).

An epiphytic species which has been certainly overlooked in the past. In Italy it was previously known only from Sardinia. Sorediate specimens with the same anatomical characters of the apothecia are referred to *C. obscurella*, which has been recently collected in the Emilian Apennines (TSB).

Caloplaca saxifragarum Poelt

Carnic Alps: - Piz di Mede (UD), on *Saxifraga*, 2000 m, 09.08.1986, leg. N (7717). - Piz di Mede (UD), on *Saxifraga*, 2000 m, 09.08.1986, leg. N, rev. T (7718).

An arctic-alpine species, growing on plant remains on calciferous substrata; probably rather common, but previously cited for Italy only from Lombardy and South Tyrol.

Caloplaca sinapisperma (Lam. & DC.) Maheu & Gillet

Carnic Alps: - Piz di Mede, on epilithic mosses, on sandstone, 09.08.1986, leg. N (7742). *Julian Alps*: - M. Lopa, 2050 m, on plant remains on soil, 09.08.1983, leg. N (3375). - M. Canin, 1800 m, on mosses, 10.08.1979, leg. N (821). - M. Montasio, 2300 m, on plant remains, on limestone, 08.1981, leg. N (2203). - Altopiano del Montasio, near La Casera, 1520 m, on plant remains, on calcareous substratum, 22.07.1989, leg. Bersan (12880).

This species has an arctic-alpine distribution and grows on plant remains on more or less calcareous substrata. In Italy it is confined to the Alps; it was not previously reported from the survey area.

Caloplaca subpallida Magnusson

Carnic Alps, Passo M. Croce Carnico, 1250 m, on *Aspicilia*, on sandstone, 28.10.1982, leg. N (2875).

C. subpallida is a rarely-collected and rather poorly-understood species, with probable optimum on base-rich siliceous rocks. The specimen cited here fits well with the description given by Clauzade & Roux (1985).

Caloplaca tetraspora (Nyl.) H. Olivier

Carnic Alps: - Lateis (UD), Forcella di M. Novarza, on plant remains on soil, c. 1870 m, 28.09.1988, leg. L. Quaranta (10866).

This mainly Arctic species is rather rare in the Alps compared with the similar *C. sinapisperma*, and for Italy it was known only from South Tyrol.

Caloplaca tirolensis Zahlbr.

Carnic Alps: - M. Tinisa (UD), on plant remains on soil, 1840 m, 02.09.1988, leg. T (10756). - Passo Volaia (UD), on plant remains, 1850 m, 08.08.1979, leg. N (819).

The distribution of this arctic-alpine species extends to the Mediterranean mountains; it is a rarely collected lichen, which is similar to *C. saxifragarum*.

Caloplaca viperae (Zahlbr.) H. Olivier

Friulian Plain: - Mariano del Friuli (UD), on *Populus*, 27.12.1982, leg. N (3108).

Karst: - Opicina (TS), epiphytic, 17.02.1980, leg. De Faveri & N, det. N (975). - Opicina (TS), epiphytic, 300 m, 01.12.1980, leg. N, rev. Poelt (2490). - Opicina (TS), epiphytic, 12.12.1980, leg. De Faveri & N (1096).

In Italy this species is known only from the survey area, where it is not common. It is characterized by a green-grey, sorediate thallus, and bright orange, biatorine apothecia. Its ecology and distribution are very poorly-known (Poelt, 1969).

Caloplaca xantholyta (Nyl.) Jatta

Carnic pre-Alps: - Meduno (PN), on limestone, 02.1985, leg. Loi (4966). - Pradis di Sotto (PN), on limestone in shaded gorge, 28.05.1985, leg. Loi (5613).

Karst: - Gropada (TS), on limestone in a dolina, 25.08.1988, leg. Bersan (10029). - Val Rosandra (TS), 120 m, calcareous rock, north exp., 19.07.1979, leg. N (760). - Dolina near Malchina, 180 m, on limestone, in a niche, north exp., 10.02.1984, leg. N (3987). - Costa dei Barbari (TS), 20 m, on limestone, in vertical face in shadow, 2.10.1984, leg. N (4586). - Sales (TS), in a dolina, on limestone, 17.09.1983, leg. N (3616). - Sgonico (TS), on limestone, in a dolina, 25.01.1988, leg. Bersan (10030). - Monrupino (TS), 400 m, on limestone, in shadow, 28.06.1981, leg. Loi & N (1603).

A species preferring underhanging surfaces in rather humid areas. It is widespread throughout Italy, and in the survey area is particularly frequent in the Karst region.

Candelariella coralliza (Nyl.) Magnusson

Carnic Alps: - M. Tenchia, above C.re Zoupflan, 1750 m, on acid rocks, 29.05.1989, leg. Bersan & Codogno (13889).

The distinction of this species from certain forms of *C. vitellina* is not always easy. It is certainly more frequent in the alpine belt, mainly on acidic substrata.

Candelariella lutella (Vain.) Räsänen

Carnic Alps: - Passo Pura, 1440 m, on lignum, 04.09.1986, leg. Nimis (TSB 7836).

C. lutella was rarely reported from Italy; it was previously known only from Veneto, Emilia-Romagna and South Tyrol. It belongs to the *C. vitellina*-complex, grows on the bark of broad-leaved trees (*Juglans*, *Alnus*, *Fraxinus*) and is characterized by an endophloedic or very poor-developed thallus.

Candelariella subdeflexa (Nyl.) Lettau

Karst: - S. Antonio in Bosco, c. 150 m, on *Populus*, along the road, 25.03.1992, leg. N (16259).

This species is characterized by the biatorine, vivid yellow apothecia and grows on eutrophic bark, mainly *Populus* and *Ulmus*, with a strong accumulation of calcareous dusts.

Carbonea vitellinaria (Nyl.) Hertel

Carnic Alps: - M. Tenchia (Cervinto, UD), 1400 m, on siliceous rock, 12.06.1988, leg. Bersan (10450).

A parasitic lichenicolous fungus, growing mainly on *Candelariella vitellina*; in Italy it is most common in the montane belt; new to the survey area.

Carbonea vorticosa (Flörke) Hertel

Carnic Alps: - M. Novarza (UD), 1400 - 1600 m, on sandstone, 09.1989, leg. N (14120).

This is an arctic-alpine, bipolar species, preferring vertical faces of decalcified sandstone and metamorphic rocks. The species was reported from several localities in the Alps, but it is new to the survey area.

Catapyrenium imbricatum (Nyl.) Clauz. & Roux

Karst: - Cernizza (Duino - Aurisina, TS), above the ILVA quarry, c. 15 m, on calcareous boulders, 23.03.1992, leg. T (15974).

This species is relatively frequent in the coastal, calcareous area of the Trieste Province with Mediterranean vegetation, but is not common in Italy. The identification was checked against a recent, abundant collection from Sardinia.

Catillaria minuta (Schaerer) Lettau

Carnic Alps: - Passo Rest, 1100 m, on limestone, in beech forest, 14.10.1983, leg. N (3663). - Passo Pura (UD), 1440 m, on limestone, in beech forest, 07.08.1985, leg. N (7814). *Friulian Plain*: - Meduno (PN), 300 m, on limestone, 02.1985, leg. E. Loi (4979). - Lestans (PN), on limestone, 02.1985, leg. E. Loi (5350). *Julian Alps*: - Laghi di Fusine, 1700 m, on limestone, 06.11.1983, leg. Palma (3752). *Julian pre-Alps*: - Val del Torre, near Crosis (UD), 350 m, on calcareous face, north exp., 05.12.1982, leg. N (3001).

This lichen, which was rarely collected in Italy, is very frequent in the region, mainly on calcareous outcrops or vertical rock faces in beech forests.

Cetraria ericetorum Opiz

Carnic Alps: - M. Paularo (UD), 1950 m, on wind-swept ridge, 16.08.1981, leg. N (1708). - Piz di Mede (UD), 2000 m, on soil, on wind-swept ridge, 09.08.1986, leg. N (7682). - M. Dimon (UD), 1900 m, on wind-swept ridge, 08.1983, leg. N (3381). - M. Paularo (UD), 2000 m, on soil, 29.09.1990, leg. Castello & T (14756). - Passo Volaia, 1950 m, on soil, on wind-swept ridge, in *Thamnotietum*, 07.08.1981, leg. De Faveri & N (1973). *Julian Alps*: - M. Zabus (UD), 2200 m, on soil, in a ridge, 02.08.1979, leg. N (918). - M. Canin (UD), 2000 m, on soil, on wind-swept ridge, 07.1980, leg. De Faveri & N (1354).

This species is rather frequent in alpine, siliceous districts of the survey area, mainly in wind-swept ridges. It is widespread throughout Italy, but it seems to be very rare along the Apennines.

Cetraria hepatizon (Ach.) Vainio

Carnic Alps: - M. Paularo (UD), 2000 m, on siliceous rock, 16.08.1981, leg. N, rev. T (1709). - M. Paularo (UD), 2000 m, on siliceous rock, 16.08.1981, leg. N, rev. T (1698). - M. Crostis, 2000 m, on sandstone, on a ridge, 05.09.1983, leg. N, rev. T (3495). - M. Paularo (UD), 2000 m, on siliceous rock, 16.08.1981, leg. N, rev. T (1710). - Piz di Mede (UD), on siliceous rock, on a ridge, 09.08.1986, leg. N (7729).

Cetraria hepatizon is rather common on wind-exposed siliceous rocks in the Alpine belt. In our region the closely related *C. commixta* has never been found.

Cetraria oakesiana Tuck.

Carnic Alps: - Passo Pura (UD), Bosco della Stua, 1100 m, on *Abies alba*, 11.09.1987, leg. N & T (9727). - Lago di Sauris (UD), bosco della Stua, 1000 m, on *Abies alba*, 15.09.1986, leg. N (6454).

A circumboreal species, which has been rarely cited from Italy. It grows on acid bark, mainly at the base of the trunks, in humid situations with stagnation of cold air. It is very rare in the Carnic Alps. New to Friuli.

Chaenothecopsis debilis (Sm.) Tibell

Carnic Alps: - Arta Terme (UD), gorge E of the village, on *Larix*, with *Chrysotrix candelaris*, 30.07.1988, leg. Bersan, det. D. Puntillo (10670).

This species is widespread in the cold-temperate and temperate areas of the world; it grows on dry lignum in open situations. New to the survey area.

Chromatochlamys muscorum (Fr.) H. Mayrh. & Poelt

Julian Alps: - Laghi di Fusine, 1450 m, on mosses, 23.07.1984, leg. N (4347).

C. muscorum grows on mosses in rather humid situations, and is not uncommon throughout Italy, but in the past it was certainly overlooked. New to Friuli.

Cladonia bellidiflora (Ach.) Schaerer

Carnic Alps: - Passo Pramollo, 1600 m, on a marcescent stump, 10.05.1981, leg. De Faveri & N (1368).

This is an arctic-alpine species of raw humus and mossy rocks in humid situations, occurring above the lower montane belt. New to Friuli, where it is not frequent.

Cladonia botrytes (Hagen) Willd.

Julian Alps: - Foresta di Tarvisio, above Valbruna, 1200 m, on a stump of *Picea*, 20.11.1982, leg. N (2947).

A nice *Cladonia* growing on relatively recently cut conifer stumps and wood in boreal environments. It is easily distinguished for its small size, yellow-green podetia and pale brown, pinkish apothecia. For the region, there was only an old, dubious citation by Jatta (1909-1911) from the surroundings of Cividale.

Cladonia caespiticia (Pers.) Flörke

Karst: - Dolina di Percedol, on an old *Quercus*, 25.07.1991, leg. N (15239).

A suboceanic lichen, which in the survey area was collected only once, in a large dolina. It usually grows on mineral acid soil in the montane belt, and is rather uncommon.

Cladonia carneola (Fr.) Fr.

Carnic Alps: - M. Brutto Passo, 1750 m, on decaying stump, 16.09.1985, leg. N (6501). - M. Cason di Lanza, 1550 m, on a stump, 23.07.1984, leg. N (4379). - Piz di Mede, 1950 m, on acid soil, in *Rhodoretum*, 09.08.1986, leg. N (7701).

C. carneola seems to be more frequent in the region than the few citation might suggest. It grows on raw humus and decaying wood in boreal-arctic habitats, and might have been confused with similar species. New to Friuli.

Cladonia coccifera (L.) Willd.

Carnic Alps: - M. Lagna, 1900 m, on soil, in *Rhodoro-Vaccinietum*, 10.09.1984, leg. N (4564). - Above Passo Pramossio, 2080 m, on acid soil, 02.08.1985, leg. Vidali (6308).

This species is rather frequent on raw humus in the subalpine-alpine belts, mainly in stands with *Rhododendron* and *Vaccinium*. In the survey area it is apparently present only in the inner Carnic Alps, where it is locally frequent.

Cladonia convoluta (Lam.) Anders

Friulian Plain: - Grado, dunes near P.ta Spina, 5 m, 18.03.1967, leg. Pignatti (12820). *Julian pre-Alps*: - M. Glemina, on soil, 850 m, 08.06.1981, leg. De Faveri & N (1479).

Karst: - Gropada, in a dolina, 25.01.1988, leg. Bersan, 10027.

This *Cladonia* has a submediterranean distribution, occurring in dry, warm limestone areas of southern and southern-central Europe. In the Karst it is very common, mainly in open grassland vegetation, while in Friuli it is restricted to the outer pre-Alps and to the "magredi", which are para-steppic environments developed on gravel deposits in the upper plains.

Cladonia crispata (Ach.) Flotow

Carnic Alps: Casera Razzo (BL), 1800 m, on acid soil, with *Sphagnum*, 16.09.1985, leg. N (6495).

C. crispata is a circumboreal lichen growing on acid soil or on lignum, with optimum in the subalpine belt. In the survey area it has been collected only once.

Cladonia deformis (L.) Hoffm.

Carnic Alps: - High Pesarina valley, 1300 m, on a bole, 03.09.1983, leg. N (3698). - M. Brutto Passo, 1700 m, on a bole, 21.08.1983, leg. N (3423).

A very variable species, which, according to several authors, could be split into two different taxa, *C. deformis* s.str. and *C. sulphurina*; many populations show intermediate characters.

Cladonia diversa Asperges

Carnic Alps: - Casere Razzo (BL), 1800 m, on acid soil, 04.09.1986, leg. N, det. T. Ahti (7825).

This species was recently distinguished from *C. coccifera* and *C. pleurota* on the basis of its chemistry, but the relations among these taxa are still unclear. New to Italy.

Cladonia ecmocyna Leighton

Carnic Alps: - M. Crostis, 1800 m, on soil, 05.09.1983, leg. N (3491).

C. ecmocyna seems to be rather rare in Italy, being previously known only from a few, old records from Veneto, South Tyrol and Lombardy. It grows on raw humus developed on acid rocks in the subalpine-alpine belts and has a circumpolar distribution. New to the region.

Cladonia subrangiformis Sandst.

Karst: - Val Rosandra, 14.12.1981, leg. Loi & N (2433). - Basovizza, 400 m, 20.01.1982, leg. N (2440).

This lichen grows on more or less calcareous soils and its distribution is centered on southern and central Europe. In the survey area it is not common.

Cladonia gracilis (L.) Willd.

Carnic Alps: - M. Tenchia, 1800 m, on soil, 26.06.1988, leg. Bersan (10664). - M. Novarza, 1800 m, on soil, 11.09.1984, leg. N (4487). - M. Crostis, 2000 m, on soil, 05.09.1983, leg. N (3531).

This is a very variable species which has a broad distribution, extending to both Hemispheres. The identification of some specimens is doubtful, and could be referred to the following species. New to the region.

Cladonia macroceras (Delise) Havaas

Carnic Alps: - M. Coglians, above Rif. Marinelli, 2100 m, 09.1982, leg. N (2715). - Passo Pura, 1250 - 1400 m, on soil, 10.09.1986, leg. T (11471). - M. Lagna, 1800 m, in *Rhodoro- Vaccinietum*, 10.09.1984, leg. N (4561). - Passo Pramollo, 1600 m, on soil (protoranker), 10.05.1981, leg. De Faveri & N (1369). - M. Chiadenis, 1400 m, on soil, 25.09.1983, leg. Palma (3643). - M. Paularo, 2000 m, on soil (ranker), 16.08.1981, leg. N (1718). - M. Tenchia, Cercivento (UD), on soil, 1800 m, 26.06.1988, leg. Bersan (10659). - M. Tiarfin, 1850 m, on soil, on calcareous substratum, 08.09.1984, leg. N (4474). - M. Tiarfin, 2100 m, on soil, on acid substratum, 09.1982, leg. N (2627). - Casera Razzo (BL), 1750 m, on soil, in *Rhododendretum*, 13.07.1981, leg. Fragiaco & N (1760). *Julian Alps*: M. Canin, 1950 m, on soil, 08.1981, leg. N (2216).

This species is very abundant in the subalpine heathlands with *Rhododendron* and *Vaccinium* species. It has a holarctic distribution and is frequent in the survey area.

Cladonia macrophyllodes Nyl.

Carnic Alps: - Casera Razzo (BL), 1850 m, on soil, 04.09.1986, leg. N (7828). - M. Tiarfin, 2200 m, 09.1982, leg. N (2632). *Julian Alps*: - M. Canin, 2000 m, on soil, 28.07.1983, leg. Zuccarello (3351).

In Italy this arctic-alpine species is known only from a few, scattered stations. It grows mainly on acid soil, in open, dry grassland vegetation in the alpine belt.

Cladonia parasitica (Hoffm.) Hoffm.

Carnic pre-Alps: - Bacino del Prescudin, 750 m, at the base of *Fagus*, 29.08.1985, leg. Loi (6379). *Friulian Plain*: - Tarcento, 250 m, 19.04.1981, leg. N (1320). *Julian pre-Alps*: - Sedilis (Tarcento, UD), 450 m, on decaying stump of *Castanea*, in open woodland, 10.11.1984, leg. N (4619).

C. parasitica grows on decaying lignum of *Castanea* and *Quercus*, in the lower montane belt. It is not very frequent in the survey area, but it may be easily overlooked. New to the region.

Cladonia pleurota (Flörke) Schaerer

Carnic Alps: - Passo Pramollo, 1800 m, on soil, on mosses, 05.08.1981, leg. N (1890). - F.lla Tragonia, 1900 m, on acid soil, 08.1981, leg. N (5719). - M. Novarza, 1850 m, on soil, on sandstone, in *Rhodoro- Vaccinietum*, 11.09.1984, leg. N (4495). - M. Tiarfin, 1900 m, on soil, 20.09.1981, leg. Loi & N (2007). - M. Lagna, 1980 m, on soil, on acid substratum, in *Rhodoro- Vaccinietum*, 10.09.1984, leg. N (4560). - Casera Razzo (BL), 1750 m, on soil, 11.08.1981, leg. N (1985). - M. Paularo, 1950 m, on soil, on siliceous substratum, 16.08.1984, leg. N (4458). - M. Crostis, 1900 m, on soil, on a ridge, 05.09.1983, leg. N (3530). Lago di Sauris, Bosco Flobia, c. 1040 m, on soil, 28.09.1988, leg. T.

This sorediate species is quite common in the subalpine-alpine belts of the region, where it grows on wood or acid raw humus.

Cladonia rei Schaerer

Friulian Plain: - Meduno (PN), 300 m, on soil, 02.1985, leg. Loi (4982). *Julian pre-Alps*: - Villanova delle Grotte (Tarcento, UD), 700 m, on soil, 26.06.1985, leg. N (5923).

Karst: - S. Martino del Carso (GO), 60 m, on soil, in dry meadow, leg. N (378). - Basovizza (TS), 400 m, on soil, 09.1982, leg. Loi (2705). - Basovizza (TS), 400 m, on soil near a trail, in *Seslerio-Quercetum petraeae*, 09.1981, leg. N (2465). - Aurisina (TS), 110 m, near the coast, near the evergreen forest, on red soil, 24.03.1979, leg. Marson (554). - Aurisina (TS), in a *Quercetum ilicis* stand, on soil, 24.03.1979, leg. Marson (553).

C. rei grows on calcareous soil, in the submediterranean zone, in grassland vegetation. In the region it is not uncommon, mainly in the Karst area, on soils developed on calcareous sandstone.

Cladonia symphyarpa (Flörke) Fr.

Carnic Alps: - M. Zoufplan, 1999 m, on bare soil, 19.02.1989, leg. Bersan. - Between Timau and Passo M. Croce Carnico, 1100 m, on soil, 28.10.1982, leg. N (2870). - Passo del Pura, 1440 m, on soil, on limestone, 04.09.1986, leg. N (7841). *Carnic pre-Alps*: - Claut, on soil, in dry grassland on calcareous substratum, 15.05.1983, leg. Loi (3406).

Karst: - Val Rosandra, M. Stena, 320 m, on calcareous soil, 03.09.1986, leg. N (7483). - M. Grisa, 180 m, on calcareous soil, 10.09.1985, leg. N (5758).

C. symphyarpa grows on mineral calcareous soil, often directly on gravel, and is rather frequent from Arctic to Central Europe. New to the region.

Cladonia uncialis (L.) Wigg.

Carnic Alps: - M. Paularo, 2000 m, on soil, 16.08.1981, leg. N (1701). - M. Dimon, 1900 m, 10.08.1983, leg. N (3376). - Piz di Mede, 2000 m, on terricolous mosses, 09.08.1986, leg. N (7697). - M. Crostis, 2000 m, on soil, on wind-swept ridge, 05.09.1983, leg. N (3488).

A circumboreal species of acid soils known from several localities in Italy. In the survey area it is not uncommon in wind-exposed sites of the subalpine belt.

Coelocaulon aculeatum (Schreber) Link

Carnic Alps: - M. Paularo, 1950 m, on soil, 28.09.1990, leg. Castello & T (14760). M. Paularo, 2000 m, on soil, 16.08.1981, leg. N (1696). - M. Crostis, 2000 m, on soil, 04.09.1983, leg. N (3482).

In the survey area this species is linked to wind-swept ridges with siliceous substrata in the alpine belt. *C. aculeatum* is closely related to *C. muricatum*, a species which has never been found in our region. The two species have a similar ecology and world distribution, but they seem to differ in the anatomy of the thallus.

Collema subnigrescens Degel.

Carnic Alps: - Ligosullo (UD), 1000 m, on *Pyrus malus*, 08.1981, leg. N (2257).

Karst: - Rupinpiccolo, 289 m, on *Tilia*, 10.10.1985, leg. Nimis (6535). - Basovizza, 450 m, on *Q. pubescens*, 23.03.1981, leg. N (1127). -

A suboceanic, epiphytic species, most frequent in areas with a rather humid climate. New to Friuli.

Collema undulatum Flotow

Julian pre-Alps: - Passo di Tanamea, 700 m, on limestone, 27.09.1987, leg. N & T (9829).

This species is widely distributed in the calcareous areas of Europe, growing directly on stones. New to Friuli.

Cornicularia normoerica (Gunn.) Du Rietz.

Carnic Alps: - M. Crostis, c. 2200 m, on the top of a siliceous boulder on a ridge, 05.09.1983, leg. N (3500). - M. Paularo, 2000 m, on siliceous rock, 16.08.1981, leg. N (1695). - M. Paularo, 2000 m, on siliceous rock, 16.08.1981, leg. N (1693). - M. Carnizza, near Passo Pramollo, 1600 m, on acid rock, 29.05.1989, leg. Bersan & Codogno. - Piz di Mede, 2000 m, on sandstone, on a ridge, 09.08.1986, leg. N (7681).

An arctic-alpine species, extending to the high Mediterranean mountains and to the Caucasus, growing on siliceous rocks in wind-swept ridges. Rather frequent in the Carnic Alps; new to Friuli.

Dactylina madreporiformis (Ach.) Tuck.

Julian Alps: - M. Montasio (UD), 1700 m, on soil, 23.08.1981, leg. Visintin (1834). - M. Canin, F. chia di Terra Rossa, 2137 m, on soil (*Firmetum*), 26.08.1978, leg. Lausi (289). - M. Lopa (UD), 2250 m, on soil, 10.08.1981, leg. De Faveri & N (1778).

This circumarctic-alpine species of calcareous mineral soil was already reported from our region by Glowacki (1874). Also recently, this species has been collected only in the Julian Alps, but it could occur also in the Carnic Alps as well.

Degelia atlantica (Degel.) P.M. Jörg. & P. James

Karst: - Ceroglie, 150 m, on *Q. pubescens*, north exp., 15.05.1984, leg. Nimis, rev. P. James (4141).

In Europe this species has a mediterranean-atlantic distribution, and it should be a little more hygrophytic than *D. plumbea*, which was never found in the Karst. New to the survey area.

Dimelaena oreina (Ach.) Norman

Carnic Alps: - M. Nieddis (UD), 1750 m, on siliceous rock, in an underhang, 06.01.1990, leg. Bersan (13600).

This species, which is rather frequent in the central and western Alps, is very rare in the survey area, probably due to the prevailing suboceanic climate conditions; it has been collected only once, in the inner Carnic Alps.

Dimerella lutea (Dickson) Trevisan

Karst: - Aurisina (TS), in a doline, on *Q. petraea*, 11.03.1986, leg. N & T (8349). - Borgo Grotta (TS), in a large dolina, 230 m c., on *Q. petraea*, 03.09.1991, leg. T (15354).

This suboceanic-pantropical species is very rare in the Karst area, and it is limited to warm-humid situations in large dolinas; the apothecia are rare and not well-developed, but the identification is certain.

Dimerella pineti (Ach.) Vezda

Karst: Basovizza, 450 m, on *Pinus nigra*, 12.03.1988, leg. Castello (10136). - Cernizza (Duino-Aurisina), 10 m, on *Pinus halepensis*, leg. T (14681). - Slovenia, between Lokev and Divaca, Risnik dolina, c. 330 m, on *Tilia*, 21.05.1990, leg. T (14073).

This mainly epiphytic species is rather frequent in the Karst area with *Pinus* plantations, and it seems to prefer acidic substrata. New to the Karst.

Diploicia canescens (Dickson) Massal.

Karst: - Contovello (TS), c. 200 m, on sandstone, 04.1988, leg. T (10482). - Contovello (TS), c. 160 m, on sandstone, 26.12.1988, leg. T (10954). - Contovello (TS), 230 m, on sandstone, 13.05.1988, leg. T (11464). - Lago di Doberdò, M. Castellazzo, 150 m, on calcareous rocks, 15.02.1991, leg. T (11665).

D. canescens has a wide range in subatlantic districts of Europe, and has a broad total distribution. It is very common on the small Italian islands, and along the Thyrrenian coasts. In the survey area it is restricted to coastal sites; at Doberdò, the species is not rare in small crevices of south-facing, overhanging calcareous faces on the top of the hills surrounding the lake. New to the region.

Diploschistes actinostomus (Ach.) Zahlbr.

Karst: - Contovello (TS), on sandstone, ca. 180 m, 01.01.1988, leg. T (10966).

This is a subcosmopolitan species, occurring below the montane belt, mainly on base-rich siliceous rocks. It is very rare in the coastal area of the Trieste Province, on decalcified sandstone. New to the region.

Diploschistes gypsaceus (Ach.) Zahlbr.

Carnic Alps: - M. Novarza, 1850 m, on calcareous sandstone, 11.09.1984, leg. N (4451). - M. Tinisa, 1550 m, on limestone, in shadow, 09.08.1981, leg. De Faveri & N (1812). - Casera Razzo (BL), 1700 m, on limestone in shadow, north exp., 13.07.1981, leg. Fragiaco & N, (1667). - M. Chiadenis, 2400 m, on limestone, 25.09.1983, leg. Palma (3647). *Julian pre-Alps*: - M. Matajur, 1300 m, on limestone, 05.06.1981, leg. Loi & N (1494).

This species of shaded calcareous rocks, often occurring in fissures, is frequent throughout Italy but it was not previously known from Friuli.

Diploschistes muscorum (Scop.) R. Sant.

Carnic Alps: - M. Novarza, 1650 m, on epilithic mosses, 11.09.1984, leg. N (4496). - Piz di Mede, 1850 m, on epigeic mosses, 09.08.1986, leg. N (7721).

One of the most common *Diploschistes* species, growing on mosses, or parasitically on other terricolous lichens when young. New to Friuli.

Dirina massiliensis f. soreliata (Müll. Arg.) Tehler

Karst: - S. Caterina Cave (S. Pelagio), c. 190 m, on limestone, 08.02.1989, leg. T (11678).

In the survey area, this species is limited to shaded sites near caves or gorges, but it is absent along the coast. New to the survey area.

Encephalographa elisae Massal.

Karst: - Dolina di Percedol, c. 300 m, on limestone, in a niche, 16.06.1992, leg. N & T (16398).

This species has a Mediterranean distribution, and occurs on shaded, humid calcareous rocks. In our region it is also present in the outer pre-Alps, in narrow, humid gorges which host other interesting lichens. New to the Karst.

Epilichen scabrosus (Ach.) Clemens

Carnic Alps: - M. Paularo, 1950 m, on *Baeomyces placophyllus*, 10.08.1983, leg. N, ref. W. Obermayer (3357).

This is a parasite on the thalli of different species of the genus *Baeomyces*. It is not frequent in the Alps, but has been certainly overlooked. New to Friuli.

Fellhanera subtilis (Vezda) Diederich & Serusiaux

Julian Alps: - M. Florianca, 1600 m, on *Vaccinium myrtillus*, in a *Sphagnum* bog, 20.07.1991, leg. T (15273).

This species grows on living twigs of *Vaccinium myrtillus* in humid, rather cold situations, mainly in bogs or *Calluna*-stands and it is characterized by triseptate spores and a true exciple of broad ellipsoid to globose cells. *F. subtilis* is new to Italy, but it should be certainly much more common in the Alps, being easily overlooked.

Fulgensia australis (Arnold) Poelt

Carnic Alps: - M. Coglians, above rif. Marinelli, 2100 m, on limestone, 13.11.1983, leg. Palma (3818). - Passo Volaia, near the Austrian border, c. 2000 m, calcareous faces, 28.09.1990, leg. T (15903).

In the field this species can be easily mistaken for a lobate *Caloplaca*. It grows on calcareous rocks, in the subalpine and alpine belts of the southern European mountains, and it is characterized by falcate, uniseptate (more rarely triseptate) spores. For Italy it was known only from South Tyrol, and from the Julian Alps (Glowacki 1874). New to the Carnic Alps.

Fuscidea cyathoides (Ach.) V. Wirth & Vezda

Carnic Alps: - Conca di Sauris (UD), beech wood above Lateis, 1200 m, on *Fagus*, 07.08.1986, leg. N (7782). - Surroundings of Passo Pura, 1250- 1400 m, on *Fagus*, 10.09.1986, leg. T (11462). - Lago di Sauris, Bosco della Stua, 1150 m, on *Fagus* in *Abieti-Fagetum*, 13.09.1984, leg. N (4486). *Friulian Plain*: -

Usago (PN), 300 m, on *Carpinus*, north exp., 02.1985, leg. Loi (5332). *Julian Alps*: - Valbruna, Malga Saisera, 1080 m, on *Fagus*, leg. N (7892).

This lichen grows both on siliceous rocks and on bark. In the survey area it has been collected only on *Fagus*, and it is rather common in humid montane woods, much rarer at low altitudes.

***Gyalecta geoica* (Wahlenb.) Ach.**

Carnic Alps: - M. Tiarfin, 2200 m, on terricolous mosses, 09.1982, leg. N.

This species has been rarely collected in Italy, with a single old record from Lombardy, and a recent one from the Carnic Alps (Clerc 1984).

***Gyalecta leucaspis* (Massal.) Zahlbr.**

Julian pre-Alps: - Above Ucea (Resia, UD), 700 m, on limestone, 26.06.1985, leg. N (5892). - High Torre valley, Passo di Tanamea (UD), 700 m, on limestone, 27.09.1987, leg. N & T (9824).

G. leucaspis grows on vertical, shaded faces of calciferous rocks in rather humid situations; in Italy it has a scattered distribution along the Alpine chain. It is rather frequent in the Torre Valley, an area with very high precipitations.

***Gyalecta subclausa* Anzi**

Julian Alps: - Laghi di Fusine, c. 1700 m, on limestone, 06.11.1983, leg. Palma (3754). - Laghi di Fusine, c. 1700 m, on limestone, 06.11.1983, leg. Palma (3743).

This species was previously reported only by Anzi (1866) from a Swiss locality near the Italian border. It is an inconspicuous lichen which grows on calciferous rocks on steeply inclined, north-exposed faces in humid situations. New to Italy.

***Gyalecta truncigena* (Ach.) Hepp**

Karst: - Costa dei Barbari (Duino-Aurisina, TS), 40 m, on *Q. ilex* in shadow, leg. T (15257). - Gropada (Basovizza, TS), 360 m, on Quercus, near a dolina, 17.11.1992, leg. T (16644).

This is a widespread, but rather rare species, growing on old trees, in areas with a more or less suboceanic climate. From the Karst it was previously cited only by Schuler (1893).

***Heppia lutosa* (Ach.) Nyl.**

Carnic Alps: - Lateis, below F.lla Novarza, c. 1650 m, on mosses and plant debris, 12.09.1991, leg. Castello & T (15363).

The only recent report of *H. lutosa* for Italy was that of Egea (1989) from Liguria. *H. lutosa* is a terricolous lichen which grows on calcareous soil. In Europe it is limited to the southern and central region of the continent.

***Heterodermia speciosa* (Wulfen) Trevisan**

Carnic Alps: - Lago di Sauris, Bosco della Stua, 1000 m, on *Salix*, 04.09.1986, leg. N (7829). - High Pesarina valley, 1100 m, on *Fagus*, 03.09.1983, leg. N (3511).

This epiphytic species is bound to suboceanic climate conditions, and is quite rare in Italy; probably it was more frequent in the past, due to lower air

pollution. In the Carnic Alps it is present only in very humid montane woods, and is rare. New to Friuli.

Hypocenomyce scalaris (Liljeblad) M. Choisy

Carnic Alps: - Casera Razzo (BL), 1800 m, on *Larix*, 20.09.1981, leg. Loi & N (2008). - M. Novarza, 1850 m, on *Larix*, 11.09.1984, leg. N (4611). - From Rif. Tolazzi towards Passo Volaja, c. 1470 m, on decorticated lignum of conifer, 28.09.1990, leg. T (15105). *Julian Alps*: - Foresta di Tarvisio, above Valbruna, 1200 m, on *Larix*, 20.11.1982, leg. N (2948). - Valbruna, Rif. Grego, 1400 m, on *Larix*, 20.11.1982, leg. N (5261). - Valbruna, Rif. Grego, 1400 m, on *Larix*, 20.11.1982, leg. N (2973). - Laghi di Fusine, 1450 m, on *Larix*, 23.07.1984, leg. N (4327).

Karst: - Basovizza (TS), 420 m, on *Pinus*, 11.02.1988, leg. Castello (10093).

This is the most common species of the genus, distributed throughout the boreal and temperate zones. It grows on lignum and conifer bark, occasionally also on charred wood. In the Karst area it is not common.

Icmadophila ericetorum (L.) Zahlbr.

Carnic Alps: - Passo Pura (UD), 1600 m, on a stump of *Picea*, 08.08.1979, leg. N (768). - Between Forni di Sopra and Passo della Mauria, 1100 m, on decaying wood, 09.1982, leg. N (2636). - Casera Razzo (BL), 1750 m, on a stump of *Larix*, 13.07.1981, leg. Fragiaco & N (1652). - M. Brutto Passo (UD), 1700 m, on a stump, 21.08.1983, leg. N (3415). - High Pesarina valley, 1500 m, on decaying stump, 03.09.1983, leg. N (3541). - Lago di Sauris, 1000 m, on a stump, 09.08.1981, leg. De Faveri & N (1804). - Casera Razzo (BL), 1800 m, on acid soil, 16.09.1985, leg. N (6496). - M. Lagna, 1990 m, on soil, in *Rhodoro- Vaccinietum*, 10.09.1984, leg. N (4559). - Forni di Sopra, towards Rif. Pacherini, on a stump of *Picea*, 30.12.1984, leg. Geatti (4856). - M. Tiarfin, 2000 m, on a stump in shadow, 20.09.1981, leg. Loi & N (2027). *Julian Alps*: - Above Valbruna, 1440 m, on a stump, 08.1981, leg. N (1823). - Laghi di Fusine, 1700 m, on decaying stump, 06.11.1983, leg. M. Palma (3734). - Sella Nevea, 1750 m, on a stump of *Larix*, 10.08.1981, leg. De Faveri & N (1767).

A common species with a circumboreal-montane distribution, growing on raw humus, decaying wood, and *Sphagnum*-carpets. It is very frequent in the Alps, while it is rather rare along the Apennines.

Ionaspis epulotica (Ach.) Arnold

Carnic Alps: - Passo Pura (UD), 1450 m, on shaded calcareous rocks, 07.08.1986, leg. N (11305). - Passo Pura, 1440 m, on limestone, in beech forest, 07.08.1986, leg. N, rev. T (7770). *Carnic pre-Alps*: - Passo Rest (UD), 1100 m, on limestone, in beech forest, 14.10.1983, leg. N (3677). *Julian Alps*: - Laghi di Fusine (UD), 1700 m, on limestone, 06.11.1983, leg. Palma (3752). - M. Canin, 2000 m, on limestone, 10.08.1983, leg. N (4023). Jof Fuart, 2500 m, on limestone, 21.08.1983, leg. Visintin (3435).

This species is rather frequent in the alpine districts of the region, on calcareous rocks in shaded, humid situations, but there are few citations from Italy.

Ionaspis melanocarpa (Krempelh.) Arnold

Julian Alps: - Jof Fuart (UD), 1900 m, on limestone, 07.11.1983, leg. Visintin (4021). - Jof Fuart (UD), 2500 m, on limestone, 21.08.1983, leg. Visintin (3434).

In Italy this species seems to be restricted to the Alps, where it was rarely collected. It has an arctic-alpine distribution, extending to the mountains of the Balkan Peninsula. New to the region.

Lecanactis abietina (Ach.) Körber

Carnic Alps: - Lago di Sauris, Bosco della Stua, c. 1040 m, on *Abies alba*, 26.09.1990, leg. N & T (15075). - Lago di Sauris, Bosco Flobia, c. 1100, on *Picea*, 15.09.1991, leg. Bolognini, N & T (15356).

This lichen has been rarely collected in Italy, and is new to the survey area. It is rather common in the more humid sites of the Sauris Lake area, on the bark of conifers; the collections include both pycnidiate and fruiting specimens.

Lecania cuprea (Massal.) v.d. Boom & Aptroot

Karst: - Cernizza, Duino-Aurisina, on calcareous stones, 23.02.1992, leg. T., det. A. Vezda (16179).

This species, which has a rather southern and western distribution in Europe, grows on calciferous rocks in humid, rather shaded situations. According to Van den Boom (1992) it belongs to the genus *Lecania*. The cited specimen was collected in a very shaded site, in a well-developed mediterranean maquis. I observed that the apothecia appear in early spring. Apparently *Lecania cuprea* is not frequent in Italy, being known from scattered localities in the north and from only two stations in Latium and Calabria. New to the survey area.

Lecanora agardhiana Ach.

Carnic Alps: - M. Lagna, 1950 m, on limestone, 10.09.1984, leg. N (4592). *Julian pre-Alps*: - Valli del Natisone, Cepletischis, 750 m, on limestone, 28.12.1982, leg. N (3037). - M. Matajur, 1300 m, 05.06.1981, leg. Loi & N (1577). M. Glemina, 800 m, on limestone, 08.06.1981, leg. N (1499).

An endolithic lichen, growing on hard calciferous rocks, mainly from the montane to the alpine belt. It was already reported from the Karst by Glowacki (1974) and Nimis & Loi (1982). New to Friuli.

Lecanora cinereofusca Magnusson

Carnic Alps: - Lago di Sauris, Bosco della Stua, 1200 m, on *Fagus*, 11.09.1987, leg. N & T, rev. T (9742).

The identification of this specimen is almost certain, and is based on the peculiar epihymenial reaction (PD+ orange, with the formation of clusters of short crystals) and the morphology of the apothecial margins, which are verrucose or discontinuous. Unfortunately, in our collection the apothecia have no spores, and the attribution to *L. cinereofusca*, and not to the closely related *L. insignis* is based on their different ecology: the latter occurs only on conifer bark, while *L. cinereofusca* grows mainly on *Fagus*, in humid montane woods. The species is known from Europe and eastern North America. New to Italy.

Lecanora dispersoareolata (Schaerer) Lamy

Carnic Alps: - Piz di Mede, 2000 m, on schist, 09.08.1986, leg. N (7690). - M. Crostis, 1950 m, on sandstone, 05.09.1983, leg. N (3579). M. Pietinis, 2000 m, on sandstone and schist, 08.1981, leg. N (2767). - M. Paularo, c. 2000 m, on exposed siliceous rock, 29.09.1990, leg. T (15968).

A rather frequent species of intermediate substrata, distributed in the montane and alpine belts of the European mountains, not previously reported from the Carnic Alps, where it is not uncommon.

***Lecanora impudens* Degel.**

Carnic Alps: - Passo Pura (UD), 1440 m, on *Fagus*, 07.08.1986, leg. N (7769).

A rare species of montane woods, growing on bark in humid situations and distributed mainly in central Europe. New to Italy. The specimen has no apothecia.

***Lecanora muralis* v. *dubyi* (Müll. Arg.) Poelt**

Carnic Alps: - Piz di Mede, 2000 m, on calcareous sandstone, 09.08.1986, leg. N (7730).

This taxon is characterized by the almost foliose thallus with broad convex lobes. It was rarely cited in the old literature, and is new to the southern Alps, where it is rather frequent, especially on intermediate substrata.

***Lecanora polytropa* (Hoffm.) Rabenh.**

Carnic Alps: - M. Chiadin, 1800 m, on sandstone, 13.11.1983, leg. Palma (3791). M. Chiadenis, 2400 m, on siliceous rock, 25.09.1983, leg. Palma (3642). *Julian Alps*: - M. Florianca, c. 1550 m, near Malga Lussari, on porfiric rocks, 20.07.1991, leg. T (15251).

L. polytropa is one of the most polymorphic species in the genus; several infraspecific taxa have been described, but the whole complex is still in need of a revision. It grows on siliceous rocks, in very different habitats and is common in upland areas of Italy with siliceous substrata. New to Friuli.

***Lecanora pruinosa* Chaub.**

Friulian Plain: - Colle di Cormons, 200 m, on limestone, 27.12.1982, leg. N (3024). *Julian pre-Alps*: - M. Matajur, 1300 m, on limestone in shadow, 05.06.1981, leg. De Faveri & N (1473).

Karst: - Lago di Doberdò (GO), c. 150 m, M. Castellazzo, in vertical niches, south exp., 15.02.1989, leg. T (11663). - Sistiana (Duino- Aurisina, TS), 70 m, vertical calcareous face, 31.05.1985, leg. N (5685).

A southern European species, more frequent on calcareous rocks, with a subatlantic tendency. In the Karst area it is rather common, mainly on south-exposed, vertical faces. The specimen from M. Matajur has a very weak reaction to C.

***Lecanora rupicola* (L.) Zahlbr.**

Carnic Alps: - M. Paularo, 1990 m, vertical, north-exposed face, 10.08.1983, leg. N, rev. T (3362). - Piz di Mede, c. 2000 m, on siliceous rocks, 09.08.1986, leg. N (8330). - M. Tenchia (Cercivento, UD), 1400 m, on siliceous rocks, 12.06.1988, leg. Bersan (10451).

This species is very common on a wide variety of siliceous rocks, from the lowlands to the alpine belt; in Friuli it is limited to the inner Carnic Alps. New to the survey area.

***Lecanora subaurea* Zahlbr.**

Carnic Alps: - M. Zoufplan (Cercivento, UD), 1900 m, on siliceous rock, 19.02.1989, leg. Bersan, rev. T (12802).

The thallus of this rare lichen is formed by small, convex areolae with peripheral, lemon-yellow soralia, reacting P+ orange. It grows on steep to

overhanging faces of metal-rich siliceous rocks, in the alpine belt. For Italy there is only a rather dubious record from Sicily by Poli et al. (1990).

Lecanora subintricata (Nyl.) Th. Fr.

Carnic Alps: - M. Brutto Passo, 1750 m, on *Larix*, 21.08.1983, leg. N (3411). *Julian Alps*: - Foresta di Tarvisio, Valbruna (UD), 1100 m, 20.11.1982, leg. N (2958).

This species is distributed from the boreal zone to upland areas of central Europe, and mainly grows on the bark and lignum of conifers. It was rarely cited from Italy (South Tyrol, Lombardy, Piedmont), but it has been probably overlooked. New to the region.

Lecanora umbrosa Degel.

Carnic Alps: - M. Novarza (UD), 1700 m, on sandstone, 11.09.1984, leg. N (4469). - M. Pieltnis (UD), 1900 m, on Werfen sandstone, 20.09.1981, leg. Loi & N (2033). - Lago di Sauris, Lateis (UD), below F.lla Novarza, c. 1650 m, on calcareous sandstone, 12.09.1991, leg. T (15384),

For Italy this species has been previously reported only from Sardinia; it is rather frequent in the subalpine belt of the Carnic Alps where sandstone or other base-rich siliceous rocks occur. The specimens are richly fruiting.

Lecidea alpestris Sommerf.

Carnic Alps: - M. Crostis, 2000 m, on soil, 05.09.1984, leg. N (3514).

This species has an arctic-alpine distribution and grows on plant remains and raw humic soils, mainly on acid substrata. For Italy it was known only from old collections of the previous century. New to the survey area.

Lecidella carpathica Körber

Carnic Alps: - M. Pieltnis, 1800 m, on sandstone, 20.09.1981, leg. Loi & N (2044). - M. Novarza, 1650 m, on sandstone, 11.09.1984, leg. N (4498). - Lateis, above C.ra Novarzutta, 1730 m, on sandstone, 28.09.1988, leg. N & T (10860).

This is a common species of base-rich siliceous substrata, not previously reported from Friuli.

Lecidella euphorea (Flörke) Hertel

Carnic Alps: - Between Timau and M. Croce Carnico, 1100 m, on *Fagus*, 28.10.1982, leg. N (2862). - Stregna, 600 m, on *Juglans*, 08.1981, leg. Nimis (2758).

L. euphorea is an epiphytic lichen whose distinction from the more common *L. elaeochroma* is mainly based on the non-inspersed hymenium and the absence of a C+ reaction of the thallus. In the region it is rather frequent, especially in the *Fagus* belt.

Lecidella scabra (Taylor) Hertel & Leuckert

Karst: - Contovello, 200 m, on sandstone wall, 04.1988, leg. T (10486).

The specimen is sterile, but corresponds well with abundant collections from the Tyrrhenian region. *L. scabra* has a rather suboceanic distribution in Europe,

and is more frequent in the Mediterranean and Submediterranean zones. New to the region.

***Lecidella stigmatea* (Ach.) Hertel & Leuckert**

Carnic Alps: - M. Novarza, 1870 m, on sandstone, 11.09.1984, leg. Nimis (4474). - M. Lagna, 1700 m, on sandstone, 09.10.1984, leg. N (4606). *Carnic pre-Alps*: - Tarcento, 350 m, on sandstone, 26.12.1982, leg. N (3097). *Friulian Plain*: - Faedis, 160 m, on sandstone, 04.1979, leg. N (3106). - Spilimbergo, 130 m, on limestone, 02.1985, leg. Loi (5348).

Lecidella stigmatea is a common species, growing on walls, also inside urban areas. In the survey area it is rather frequent on sandstone, in the *Quercus*-belt.

***Lecidella wulfenii* (Hepp) Körber**

Carnic Alps: - Piz di Mede (UD), 1950 m, on mosses on a ridge, 09.08.1986, leg. N (7712). - M. Tinisa (UD), 1850 m, on plant remains on soil, on a ridge, 02.09.1988, leg. T (10753).

This species is distributed in arctic and alpine regions of Europe, extending southwards to the Balkan Peninsula. It grows on plant remains and raw soil on calcareous substrata. It is very common in the alpine belt of the Carnic and Julian Alps, but was little collected. New to the survey area.

***Lecidoma demissum* (Rutström) G. Schneider & Hertel**

Carnic Alps: - Ridge between M. Auernig and M. Carnizza, 1900 m, on acid soil and plant debris, 04.06.1989, leg. Bersan (13895). - Piz Chiadin, 2100 m, on acid soil, 13.11.1983, leg. Palma (3825). - M. Zoufplan, 1950 m, on soil, with *Cetraria*, 19.02.1989, leg. Bersan (12272). - M. Paularo, c. 1950 m, on acid soil, 29.09.1990, leg. T (15431).

This species, which is rather common on peaty, acidic soils in the alpine belt, has never been reported from the survey area.

***Leprocaulon microscopicum* (Vill.) D. Hawksw.**

Karst: Contovello (TS), c. 160 m, in fissure in a sandstone wall, on soil, south exp., 26.12.1988, leg. T (10808).

L. microscopicum is distributed in warm regions of the Northern Hemisphere, with a frequency maximum in Mediterranean and Submediterranean areas with a suboceanic climate. It is usually terricolous, being found in niches or protected parts of sandstone, or base-rich siliceous rocks, but it occurs also on the bark of different phorophytes (*Olea*, *Quercus ilex*, *Q. petraea*) in areas with a suboceanic climate. In the survey area it is restricted to the warmer parts of the coastal region, and is rare. New to the region.

***Leptogium cyanescens* (Rabenh.) Körber**

Carnic Alps: - High Pesarina valley, 1300 m, on mosses, near a creek, 03.09.1983, leg. N (3539). - Above Paularo, 800 m, on mosses at the base of *Fagus*, 10.08.1983, leg. N (3373). - Lago di Sauris, Bosco della Stua, 1100 m, on mosses at the base of *Fagus*, 07.09.1983, leg. N (3558). *Carnic pre-Alps*: - Val Cellina, Lesis (Claut, PN), c. 700 m, on mosses, 07.10.1986, leg. N (9717).

In Italy this suboceanic species is present along the whole Peninsula, but nowadays it is not frequent; it grows on epiphytic mosses in rather humid sites.

Leptogium diffractum Krempelh. ex Körber

Friulian Plain: - Paludea (PN), on limestone, 13.03.1985, leg. Loi (5463).

Karst: - Val Rosandra (TS), 200 m, on limestone, vertical face, 01.1984, leg. N (5537). - M. Radio (TS), 150 m, on limestone in shadow, 15.06.1985, leg. N (5789).

This *Leptogium* is a calcicolous crustose lichen, rather frequent in the Karst, on rocks with periodical water seepage.

Leptogium gelatinosum (With.) Laundon

Carnic Alps: - M. Tiarfin, 1900 m, on soil, 09.1982, leg. N (2634). - M. Lagna, 1800 m, on epilithic mosses, 10.09.1984, leg. N (4594). - C.re Razzo, 1750 m, on mosses, 07.08.1986, leg. N (7819).

L. gelatinosum is rather frequent in the alpine belt of the region, on mosses or plant remains, on calcareous substrata including limestone.

Leptogium plicatile (Ach.) Leighton

Karst: Val Rosandra, 200 m, on periodically wetted, vertical limestone face, 09.1982, leg. N (5800). - M. Radio, 150 m, on limestone in shadow, 15.06.1985, leg. N (5792).

A widespread species of calcareous rocks, rather common in the Karst area.

Leptogium schraderi (Ach.) Nyl.

Carnic pre-Alps: - Claut (PN), 700 m, on mosses, 15.05.1983, leg. Loi (3298). *Julian pre-Alps*: - M. Bernadia (UD), 600 m, on calcareous soil, 16.09.1983, leg. N (3593).

Karst: - M. Grisa (TS), 250 m, on limestone, subvertical face, 10.06.1985, leg. N (5749). - Cernizza (Duino- Aurisina, TS), near the ILVA quarry, 2 m, in a fissure of the rock, limestone, 05.02.1991, leg. T (15072). - Val Rosandra, c. 150 m, on calcareous stone in shadow, 14.12.1981, leg. Loi & N, rev. T (2304).

L. schraderi is a small, fruticose lichen growing on calcareous rocks with some soil cover; when young it is often found on epilithic mosses. It was previously cited from the Karst area by Nimis & Loi (1982, 1984), and is new to Friuli; the sample 2304 was erroneously identified by the latter authors as *Placynthium filiforme*, a species that has never been collected in the Karst.

Leptogium tenuissimum (Dickson) Körber

Julian Alps: - Foresta di Tarvisio, above Valbruna, 1100 m, on a bole, 20.11.1982, leg. N (3070).

This species can be easily mistaken for small, strongly fimbriate specimens of *L. lichenoides*. The specimen from the Julian Alps has, however, very narrow, cylindrical, rather branched laciniae; in my opinion it can be correctly named *L. tenuissimum*.

Lobaria pulmonaria (L.) Hoffm.

Karst: - Gropada, on *Q. petraea*, in a dolina, 03.1989, leg. Bersan (11650). - Slovenia, between Lokev and Divaca, c. 360 m, on *C. betulus*, 14.04.1990, leg. T (13952)

Some specimens of *L. pulmonaria*, preserved in the herbb. Biasoletto (TSM) and Schuler (PAD), were collected in the previous century in the surroundings of Trieste (Aurisina, Draga, Val Rosandra), where apparently this species was

more common. Nowadays it is very rare in the Karst area, being restricted to the largest dolinas.

Lobaria scrobiculata (Scop.) DC.

Carnic Alps: - Lago di Sauris, Bosco della Stua, 1020 m, on *Fagus*, 15.09.1985, leg. N (6455). *Julian pre-Alps*: - M. Jonaz, above Montefosca (Pulfero, UD), 820 m, on *Fraxinus excelsior*, 02.08.1985, leg. N (6298).

This is a widespread species, with suboceanic affinities, growing on bark or siliceous rocks, mainly on mosses. In the survey area it is very rare, being restricted to humid, undisturbed forests. In Italy this species was more frequent in the past, due to its sensitivity to air pollution.

Loxospora cisonica (Beltram.) Haf.

Carnic Alps: - Passo Pura (UD), Bosco della Stua, 1150 m, on *Abies*, 11.09.1987, leg. N & T.

This species was previously known only from a few collections of the last century in Veneto. It is a rare lichen of the central European mountains, growing in humid sites on the bark of old trees, mainly *Abies*.

Loxospora elatina (Ach.) Massal.

Carnic Alps: - Lago di Sauris (UD), Bosco della Stua, 1100 m, on *Abies* and *Fagus*, 15.09.1985, leg. N (6457).

L. elatina is widespread in the boreal zone, on the bark of conifers in humid situations. This species, which in Italy was collected only by Massalongo in Veneto, was already reported from the Carnic Alps by Clerc (1984). Third record for Italy.

Maronea costans (Nyl.) Hepp

Karst: - Road between Fernetti and Zolla (TS), c. 330 m, on *Q. pubescens*, 18.02.1992, leg. Castello & Campagnolo (15972).

M. constans was known for Italy only from old collections of the last century. It is a rather nitrophytic, epiphytic lichen, rather sensitive to air pollution, which in the field can be easily mistaken for a *Rinodina*. New to the survey area.

Melaspilea cfr. leciographoides Vouaux

Karst: - Between Gropada and Basovizza (TS), c. 380 m, parasite on *Petractis clausa*, on limestone, in a doline, 25.12.1992, leg. t (16653).

The identification of this taxon is not certain. *M. leciographoides* has been collected only on *Verrucaria* species (Hawksworth, 1983; Clauzade et al., 1989), while our specimen is parasitic on a well-developed, fruiting thallus of *Petractis clausa*. The anatomical characters of this specimen fit well with the description of the species.

Melaspilea proximella Norrlin

Carnic Alps: - Ampezzo (UD), 500 m s.l.m., on *Quercus*, 26.09.1986, leg. N, rev. T (7939). *Carnic pre-Alps*: - Tramonti di Sotto (PN), 600 m, on *Fraxinus ornus*, 14.10.1983, leg. N, rev. T (3657).

This species is rather rare in the Italian territory and seems to prefer the bark of deciduous trees.

Melaspilea urceolata (Fr.) Almb.

Friulian Plain: - Feletto Umberto, UD, on *Morus*, 130 m, 11.01.1983, leg. N (3104). - Colle di Cormons (GO), on *Quercus*, 27.12.1982, leg. N (3022). - Torrate (PN), 24 m, on *Morus*, 24.10.1985, leg. Loi (6592).

This lichen seems to have a rather suboceanic distribution in Europe, and prefers the bark of deciduous trees. I observed it mainly in open, mixed deciduous, submediterranean woods. New to Friuli.

Micarea lignaria (Ach.) Hedl.

Carnic Alps: - Lateis (UD), M. Novarza, c. 1870 m, on plant remains on soil, 28.09.1988, leg. N

This is said to be one of the most common species of the genus, but in the survey area it was collected only once, on plant remains on soil. It is easily distinguished by the bright orange reaction to P. New to Friuli.

Micarea misella (Nyl.) Hedl.

Carnic Alps: - Passo Pura, 1400 m, on lignum, in *Abieti - Fagetum*, 07.1981, leg. N (2225). - Cansiglio (UD), 900 m, on lignum, 09.1981, leg. De Faveri & N (2214). - Towards Passo Volaja, c. 1600 m, on decorticated lignum of a stump, 28.09.1990, leg. T (15941).

A widespread species, growing on lignum in areas with a humid climate, in Italy it is known only from the north. New to the survey area.

Microcalicium disseminatum (Ach.) Vainio

Julian Alps: - M. Florianca, near the creek Lussari, c. 1550 m, on *Picea excelsa*, 20.07.1991, leg. T, det. D. Puntillo (15352).

This species is known for Italy from a few, old collections in the Alps; it grows as a parasite on other species of *Caliciales* or as saprophyte on bark. New to the region.

Miriquickida garovaglii (Schaerer) Hertel & Rambold

Carnic Alps: - M. Paularo, 2000 m, on siliceous rocks, 16.08.1981, leg. N (1726). - M. Crostis, 2000 m, on siliceous, vertical face, 05.09.1983, leg. N (3497). - M. Paularo, c. 2050 m, on siliceous rock, 29.11.1990, leg. T (15077).

M. garovaglii seems to prefer mineral-rich siliceous rocks, and grows on wind-exposed situations in the alpine belt. It is not uncommon in the inner Carnic Alps.

Mycobilimbia lobulata (Sommerf.) Haf.

Carnic Alps: - M. Tiarfin, 2200 m, alpine meadow, on limestone, 09.1982, leg. N (2719). - Passo Pramollo, 1600 m, on calcareous soil, 25.11.1983, leg. Palma (3832). - M. Lagna, 1900 m, on mosses, on

calcareous substratum, 10.09.1984, leg. N (4600). - Passo Volaja, 2000 m, on soil, 07.09.1981, leg. N (3721). - Passo Volaja, c. 2000 m, on soil in rock fissures (limestone), 28.09.1990, leg. T. *Julian Alps*: - M. Canin, Sella Prevala, 2100 m, on calcareous soil, on wind-swept ridge, 07.1981, leg. N (2455).

M. lobulata is an arctic-alpine species, extending southwards into the highest Mediterranean mountains; it grows on calcareous soil or on terricolous mosses. It is common in the eastern calcareous Alps. New to Friuli.

***Mycocalicium subtile* (Pers.) Szat.**

Julian Alps: - M. Florianca, slope W, 1590 m, on a dry stump of *Picea*, 20.07.1991, leg. T (15353).

A widely distributed species, occurring on dry lignum in open situations and characterized by a dark greenish to brownish stalk tissue; probably overlooked in the Italian Peninsula (Puntillo, in litt.). New to Friuli.

***Nephroma bellum* (Sprengel) Tuck.**

Carnic Alps: - Passo Pura (UD), 1440 m, on *Fagus*, 07.08.1986, leg. N (7764). *Julian Alps*: - Malga Saisera, 1080 m, on *Fagus*, 29.09.1986, leg. N (7895).

N. bellum has a circumboreal-temperate, suboceanic distribution and is quite rare in the survey area. It grows on mossy bark in humid woods of the montane belt.

***Nephroma parile* (Ach.) Ach.**

Carnic Alps: - Above the Lago di Sauris, 1100 m, on *Fagus*, 09.08.1981, leg. De Faveri & N (1754). - M. Brutto Passo (UD), 1700 m, on mosses at the base of *Fagus*, 21.08.1983, leg. N (3409). - Above Lago di Sauris (UD), 1000 m, on *Fagus*, 15.09.1985, leg. N (6458). *Julian Alps*: - Laghi di Fusine (UD), 1450 m, at the base of *Fagus*, on mosses, 23.07.1984, leg. N (4313).

Karst: - Dolina near Rupingrande, 300 m, 02.1980, leg. Gerdol, rev. T (963). - Slivia (Duino-Aurisina, TS), near a doline, c. 200 m, on epiphytic mosses (*Q. petraea*), 28.04.1991, leg. T (15969).

This species is rather common in the beech belt of the region, on the mossy bark of different phorophytes. It has a large distribution extending to both Hemispheres. Only poorly-developed thalli have been found in the Karst, in the largest dolinas; their identification is not easy, but the species has been reported also by Glowacki (1874) from the same area.

***Ochrolechia alboflavescens* (Wulfen) Zahlbr.**

Carnic Alps: - M. Brutto Passo, 1750 m, on *Larix*, 21.08.1983, leg. N (3416). M. Coglians, road towards Rif. Marinelli, 1700 m, on *Larix*, 08.1981, leg. N (2761). - Casera Razzo (BL), 1750 m, on *Larix*, 19.09.1981, leg. N (1980). - Passo Pura, 1500 m, on *Larix*, 09.08.1981, leg. De Faveri & N (1824). - Above Collina (Forni Avoltri, UD), 1700 m, on *Larix*, 07.1981, leg. N (2048). *Julian Alps*: - Rif. Grego, 1400 m, on *Fagus*, 20.11.1982, leg. N (2971). - Rif. Grego, 1400 m, on bark of *Fagus*, 20.11.1982, leg. N (4195).

This species, growing on the acid bark of conifers, has a circumboreal-montane distribution. Well-developed thalli are usually found on *Larix* in the subalpine belt. All specimens have the typical yellow-orange reaction to KC.

Ochrolechia parella (L.) Massal.

Karst: - M. Valerio (TS), 120 m, on sandstone, in a wood of *Q. petraea*, 10.05.1985, leg. N (5794). - M. Radio, 110 m, on sandstone, in a wood, 15.06.1985, leg. N (5778). - Conconello (TS), on sandstone wall, strongly nutrient- enriched, 20.12.1978, leg. N (445). - Contovello (TS), slope S, 250 m, on sandstone wall, exp., 18.05.1988, leg. T (10965).

O. parella has a very wide distribution, extending to the Southern Hemisphere. In Italy it is very common on siliceous rocks, in areas with a suboceanic climate, below the montane belt. In the survey area it occurs only on sandstone outcrops in the warmer districts near the coast, and was previously reported by Glowacki (1874). Many specimens are badly developed.

Ochrolechia szatalaensis Vers.

Julian Alps: - Foresta di Tarvisio, Valbruna (UD), 1100 m, on *Picea* twigs, 20.11.1982, leg. N (2922).

This species grows mainly on the bark of conifers, and seems to be rather rare in the Italian Peninsula, being known only from South Tyrol and Calabria. It might have been confused by earlier authors with the more common *O. pallescens*, distinguished by the absence of gyrophoric acid in the apothecia.

Ochrolechia upsaliensis (L.) Massal.

Julian Alps: - M. Canin, 1500 m, on mosses on soil, 10.07.1977, leg. N, det. Poelt (447).

O. upsaliensis has a broad, arctic-alpine distribution and grows on plant remains and raw humus. In Italy it is present only in the Alps. New to Friuli.

Ophioparma ventosa (L.) Norman

Carnic Alps: - M. Paularo, 2000 m, on siliceous rock, north exp., vertical, 16.08.1981, leg. N (1715).

This species grows on hard siliceous rocks in exposed situations and has an arctic-alpine distribution. In the Carnic Alps it is not common.

Orphniospora mosigii (Körber) Hertel & Rambold

Carnic Alps: - M. Crostis, 1950 m, on sandstone wall, north exp., 07.1983, leg. N, det. Poelt (4223). - M. Crostis, 2000 m, on siliceous rock, vertical face, north exp., 05.09.1983, leg. N, rev. T (3599)

This species seems to prefer base-rich siliceous rocks; it is certainly not common in the survey area.

Pannaria conoplea (Ach.) Bory

Carnic Alps: - Lago di Sauris, Bosco Flobia, above Rio Storto, 1150 m. on epiphytic mosses (*Fagus*), 12.09.1991, leg. N & T (15380). - Passo Pura (UD), Bosco della Stua, along the lake road, c. 1100 m, on *Picea*, 11.09.1987, leg. N & T (9730). - Bosco della Stua, above the lake of Sauris, 970 m, on mosses on bark of *Fagus*, 07.09.1983, leg. N (3557). *Julian Alps*: - Malga Saisera (Valbruna, UD), 1080 m, on *Fagus*, 29.09.1986, leg. N (7898). - Foresta di Tarvisio, above Valbruna, 1100 m, on *Fagus*, 20.11.1982, leg. N (2964).

P. conoplea has a wide range, extending to America, Africa and Asia. It prefers suboceanic conditions, and in Italy is rather frequent in *Lobarion*-communities, in montane forests, usually over epiphytic mosses. It was previously reported from the Carnic Alps by Degelius (1935) and Clerc (1983).

Pannaria pezizoides (G.H. Weber) Trevisan

Carnic Alps: - Passo Volaja, near the border, c. 2000 m, on plant debris, 28.09.1990, leg. T (15938). - M. Paularo, c. 1950 m, on acid soil, among the mosses, 29.09.1990, leg. T (15428). - Lateis, F.la di M. Novarza, c. 1870 m, on acid soil, N exp., 28.09.1988, leg. T & N (11260). - M. Pieltinis, 1450 m, on acid rocks, in *Abieti-Fagetum*, 20.09.1981, leg. Loi & N, rev. P. James (1987). - M. Tiarfin, 2200 m, on soil, 20.09.1981, leg. Loi & Nimis (2026). - M. Novarza, 1870 m, on mosses and sandy soil, 11.09.1984, leg. N (4480). *Julian Alps*: - Laghi di Fusine, on epigaeic mosses, 1450 m, 23.07.1984, leg. N (4310). - M. Lopa, 1300 m, 09.08.1983, leg. N (3377).

A very common species, which grows on raw humus and plant remains, forming large crustose thalli characterized by the numerous crowded apothecia with a granular thalline margin. In Italy it is frequent in the subalpine and alpine belts, from the Alps to the Calabrian Apennines.

Pannaria praetermissa Nyl.

Carnic Alps: - Passo Volaja, on terricolous mosses, c. 1950 m, 28.09.1990, leg. T (15417).

P. praetermissa is an arctic-alpine species, present also in the southern European mountains, on mosses and soil on calcareous substrata.

Paranectria oropensis (Ces.) D. Hawksw. & Pir.

Karst: - Prezenico (Duino- Aurisina, TS), on *Quercus* sp., 120 m, 13.03.1988, leg. N & T (10143). - Prezenico (Duino- Aurisina, TS), on *Q. petraea*, c. 200 m, 16.03.1991, leg. T (15109). - Borgo Grotta (TS), in a large dolina, c. 230 m, on epilithic mosses, 03.09.1991, leg. T (15355).

This non-lichenized fungus is rather frequent in the submediterranean woods of the Karst during spring; it grows on different lichen species, mainly *Parmelias* and epiphytic *Cladonias*. We also have some collections from Istria.

Parmelia acetabulum (Necker) Duby

Carnic pre-Alps: - Cimolais, 650 m, on *Tilia*, 03.06.1988, leg. T (10535).

This species is very common throughout the region, but it was not recorded previously. It is absent from the more humid parts of the survey area, being more common in the inner dry valleys and in the Karst area.

Parmelia carporrhizans Taylor

Carnic Alps: - Collina (Forni Avoltri, UD), 1200 m, on *Sorbus*, 07.08.1981, leg. N (1964). - Villa Santina (UD), 400 m, on *Juglans*, 22.05.1987, leg. N (8024). - Ampezzo Carnico (UD), 650 m, on *Alnus*, 30.12.1984, leg. Geatti (4859). - From Ravescletto, 4 km before Comeglians, c. 750 m, on *Juglans*, 26.05.1988, leg. T (10557).

This species is widespread in the Mediterranean and submediterranean parts of Europe, but in the survey area is present only in its inner districts, being absent from the Karst and the pre-Alps. Its Italian distribution is still not clear, its clarification requiring a revision of the group of *P. carporrhizans*-*P. quercina* in Italy.

Parmelia conspersa (Ach.) Ach.

Carnic Alps: - M. Paularo, 1900 m, on siliceous outcrops and on mosses, 10.08.1983, leg. N (3367).
- Piz di Mede, 1800 m, on sandstone, 09.08.1986, leg. N (7716). *Friulian Plain*: - Near Bueris, on sandstone, 10.11.1983, leg. N (3766).

Karst: - Contovello, 150 m, on sandstone, 18.05.1988, leg. T (10958).

This is the commonest *Xanthoparmelia* of the survey area, distributed from sea level to the alpine belt. It grows mainly on siliceous rocks, but in the Karst area it is rather common also on sandstone.

Parmelia flaventior Stirton

Karst: - Duino, Cernizza, between the ILVA quarry and Villaggio del Pescatore, c. 15 m, on *Prunus mahaleb*, 21.10.1991, leg. T & Bolognini (15851).

This lichen was said to prefer continental climatic conditions, but our collections are from rather humid sites (M. Musi, see Castello & al. 1990) or just near the coast, as the cited one, which is the first known from the Karst area. In my opinion, *P. flaventior* might be more common than normally assumed, and with a larger distribution range. In the Cernizza area *P. flaventior* occurs together with the similar *P. caperata* and *P. soredians* (see later). Probably the apparent rarity of this lichen is mainly due to confusion with the very common *P. caperata*.

Parmelia loxodes Nyl.

Karst: - Altura (TS), c. 100 m, on sandstone, in open woodland of *Q. petraea*, 07.03.1988, leg. N (10101). - Contovello (TS), south slope, c. 250 m, on sandstone, 18.05.1988, leg. T (10941).

This species is distinguished from the very similar *P. verruculifera* by the presence of glomelliferic and perlatolic acid, and by the larger, more convex lobes. In the region it is restricted to the warmer sites of the coast, on decalcified sandstones. New to the survey area.

Parmelia omphalodes (L.) Ach.

Carnic Alps, M. Paularo, 2000 m, on siliceous rocks and epilithic mosses, 16.08.1981, leg. N (1706).

P. omphalodes grows on mosses and acid siliceous rocks in the alpine belt, and is morphologically variable. It was collected only once, and it is not common in the survey area, due to the scarcity of siliceous substrata.

Parmelia revoluta Flörke

Friulian Plain: - Usago (PN), 300 m, on *Prunus avium*, 02.1985, leg. Loi (5323).

Karst: - Precenico (Duino- Aurisina, TS), 120 m, on *Q. petraea*, 13.03.1988, leg. N & T (10112).

P. revoluta is an epiphytic species, which is frequent in areas with a suboceanic climate, below the montane belt. In the Julian pre-Alps it is very frequent in the *Aceri-Fraxinetum* community, while in the Karst it is very rare, occurring only in large dolinas or in areas open to humid air from the sea.

***Parmelia sinuosa* (Sm.) Ach.**

Carnic Alps: - Lago di Sauris (UD), 970 m, on *Salix*, 09.08.1981, leg. De Faveri & N (1744).

Collected only once in the survey area, in a very humid site. This species, new to Friuli, is a true oceanic lichen, and seems to be very rare in Italy.

***Parmelia somloensis* Gyelnik**

Carnic Alps: - Between Ravascletto and Tualis (UD), 850 m, on soil (sandstone), 19.02.1989, leg. Bersan (12808).

Karst: - Contovello (TS), c. 180 m, on acid sandstone, south exp., 28.11.1988, leg. T (10846).

P. somloensis is a very variable species with a broad ecological amplitude, growing on rather acid substrata (rock and soil). I have observed populations with a completely white lower cortex, and others which are dark brown, or black; also the morphology is somewhat different; they perhaps belong to different taxa. New to the survey area.

***Parmelia soledians* Nyl.**

Julian pre-Alps: - Gradischiutta (UD), c. 370 m, on *Prunus avium*, 04.11.1990, leg. Carpanelli (14749). - Campeglio (UD), c. 170 m, on *Q. petraea*, 18.07.1990, leg. T (14505). *Friulian Plain*: - Bellazzoia (Povoletto, UD), 140 m, on *Robinia pseudacacia*, 23.07.1990, leg. Carpanelli (14579).

Karst: - Basovizza, 300 m, on *Tilia*, leg. T (13235). - Duino, Cernizza, c. 25 m, on lignum, 21.12.1990, leg. T (14772). - Contovello, c. 200 m, on sandstone, 07.08.1991, leg. T (15463). - Sorgenti di Aurisina, c. 80 m, on *Pistacia terebinthus*, 23.01.1988, leg. T (11259).

This species, not previously reported from the region, has a broad pantemperate distribution, and grows both on bark and siliceous rocks. In the Karst area it is more frequent along the coast, and seems to be damaged by winter frost. In Friuli it is rather common in the narrow hill area on south-exposed slopes with a warm-temperate climate. This lichen can be easily mistaken for *P. caperata*, which differs in the laminal (not orbicular) soralia and the larger lobes not closely adpressed to the substratum.

***Parmelia subargentifera* Nyl.**

Carnic Alps: - Forni di Sopra (UD), 900 m, on *Pyrus*, 02.12.1980, leg. De Faveri (2209). - Ligosullo, 1100 m, on *Prunus*, 16.08.1981, leg. N (1858). - Ampezzo Carnico, 560 m, on *Juglans*, 07.08.1986, leg. N (7779). - Da Ravascletto, 4 km before Comeglians, c. 750 m, on *Juglans isolato*, 26.05.1988, leg. T (10569). - Ampezzo Carnico (UD), 560 m, on *Tilia*, 08.08.1986, leg. N (7746). *Julian pre-Alps*: - Val di Resia, Prato di Resia (UD), 480 m, on *Fraxinus* and *Acer*, 27.09.1987, leg. N & T (9812).

Karst: - Basovizza (TS), 400 m, on *Q. pubescens*, 08.1981, leg. Loi (2221). - Basovizza (TS), 380 m, on *Tilia*, 17.03.1989, leg. T (12223). - Gropada (TS), c. 400 m, on old *Q. pubescens*, 06.03.1990, leg. T (13723).

This species, distributed from the submediterranean to the subarctic zone, grows on the bark of isolated trees. Its distribution in Italy, extending to the eastern site of the peninsula and to the inner dry Alpine valleys, seems to suggest that the species is relatively xerophytic.

Parmelia submontana Hale

Carnic Alps: - Pierabech (Forni Avoltri, UD), 970 m, on *Abies alba*, 30.09.1986, leg. N (7881). *Julian Alps*: - Rif. Grego, 1400 m, on bark of *Fagus*, 20.11.1982, leg. N (2977).

P. submontana is widespread in the central and southern European mountains, in areas with a suboceanic climate. It grows on the bark of deciduous trees, mainly *Fagus*, being locally common, as in beech forests of the Calabrian Apennines. This species has been previously reported by Clerc (1983) from the Carnic Alps. New to the Julian Alps.

Parmelia subrudecta f. marginata Hillmann

Julian pre-Alps: Montaperta (UD), on *Prunus avium*, c. 620 m, leg. Carpanelli, det. Codogno & T, conf. Poelt (15418).

Typical *P. subrudecta* is a common species of *Parmelion* and *Xanthorion* communities, with an optimum in the submediterranean zone, below the montane belt. The f. *marginata*, not previously reported from Italy, is characterized by laminar soralia and very poorly-developed pseudocyphellae.

Parmelia verruculifera Nyl.

Karst: - Between S. Croce and Filtri di Aurisina, c. 10 m, south exp., on sandstone, 06.1988, leg. T, rev. T (10530).

This species can be distinguished from the similar *P. loxodes* on the basis of the lobe shape, which are somewhat more convex and narrow, and, more easily, by the different chemistry. *P. verruculifera* reacts C+ red, while *P. loxodes* reacts C+ pale yellow.

Parmeliella triptophylla (Ach.) Müll. Arg.

Carnic Alps: - Bosco della Stua, above the lake of Sauris, 1000 m, on *Fagus*, 04.09.1986, leg. N (7831). - Lateis (UD), 1150 m, on *Fagus*, in *Abieti- Fagetum*, 12.09.1984, leg. N (4484). - M. Novarza, 1650 m, on mosses on soil, on sandstone, 11.09.1984, leg. N, rev. Codogno & T (4459). - M. Tenchia (Cercivento, UD), 1400 m, on epigeic mosses, 12.06.1988, leg. Bersan, rev. Codogno & T (10453). *Julian Alps*: - Malga Saisera (Valbruna, UD), 1080 m, on an old *Fagus*, 29.09.1986, leg. N (7897).

This is a holarctic species, with a broad ecological amplitude, growing on bark, siliceous rocks and epigeic mosses. The specimens from the lake of Sauris are richly fruiting.

Parmotrema crinitum (Ach.) M. Choisy

Carnic Alps: - Cercivento (UD), 700 m, spruce wood, on humid soil, on mosses, 17.02.1989, leg. Pitt (11329). - Passo Pura (UD), Bosco della Stua, 1150 m, on *Picea*, 11.09.1987, leg. N & T (9732). - Bosco della Stua, above the lake of Sauris (UD), 1200 m, on *Abies alba*, in *Abieti- Fagetum*, 13.09.1984, leg. N (4481). - Pierabech (UD), 970 m, on *Abies alba*, 30.09.1986, leg. N (7884). - Lake of Sauris, Bosco della Stua, c. 1040 m, on *Abies*, 26.11.1990, leg. T (15080). - Lago di Sauris, Bosco della Stua, c. 1100 m, on *Fagus*, 09.1990, leg. Bolognini & N (14729).

This is a widespread suboceanic species of bark and epilithic mosses, occurring in humid situations. In Italy it is present only in the pre-Alps and in

the Ligurian Apennines, where it is locally abundant (Coassini et al. 1987). In the survey area it is frequent only in the surroundings of the lake of Sauris.

Peccania coralloides (Massal.) Massal.

Julian pre-Alps: - Ciseriis (Tarcento, UD), 350 m, on limestone, 05.11.1982, leg. N (2999).

Karst: - Val Rosandra, calciferous, vertical face, 14.01.1981, leg. Loi & N (2288). - Val Rosandra, 160 m, on limestone, 27.12.1981, leg. Loi & N (2392).

This species seems to be rather frequent throughout Italy, but has been rarely collected. It grows on steeply inclined, sunny faces, on calcareous substrata.

Peltigera collina (Ach.) Schrader

Carnic Alps: - Passo Pura, Bosco della Stua, road near the lake, 1100 m, on *Salix appendiculata*, 11.09.1987, leg. N & T (9735). - Lago di Sauris, 1000 m, on mosses at the base of *Fagus*, in *Lobarium pulmonariae*, 09.08.1981, leg. De Faveri & N, conf. O. Vitikainen (1742). *Julian Alps*: - Foresta di Tarvisio, near Valbruna, 1100 m, on epiphytic mosses (*Fagus*), 20.11.1982, leg. N (2929).

P. collina is a suboceanic species, which is frequent in *Lobarion*-communities, on mossy bark. In the survey area it is frequent in the *Fagus*-belt. Previously reported by Clerc (1983) and Nimis (1981) from the Carnic Alps.

Peltigera didactyla (With.) Laundon

Carnic Alps: - Passo Cason di Lanza, 1550 m, on soil, on siliceous substratum, 23.07.1984, leg. N (4370). - Casera Razzo (BL), 1730 m, on soil, 13.07.1981, leg. Fragiaco & N, conf. O. Vitikainen (1642).

A characteristic, ephemeral pioneer lichen, which grows on sandy soils or burned humus, in disturbed sites. It is known from both Hemispheres, and occurs throughout Italy. It is new to Friuli.

Peltigera lactucifolia (With.) Laudon

Julian pre-Alps: - High Torre valley, Passo of Tanamea, 700 m, on epilithic mosses, 27.09.1987, leg. N & T (9830).

This species was rarely collected in Italy, where it seems to be restricted to the Alpine regions. New to the survey area.

Peltigera lepidophora (Nyl.) Bitter

Carnic Alps: - Piz di Mede, 2000 m, on soil on acid substratum, 09.08.1986, leg. N (7728). - Road between Tualis and Ravaschetto (UD), 850 m, on soil (silice), 19.02.1989, leg. Bersan (12807).

This is a very nice species, characterized by flat isidia irregularly distributed on the small thallus, which is covered by tomentum along the margins. It has a circumboreal range, and is rather rare in the Alps. For Italy it was previously known only from South Tyrol. New to Friuli.

Peltigera malacea (Ach.) Funck

Carnic Alps: - M. Chiadin, 1900 m, on acid soil, 13.11.1983, leg. Palma (3796).

P. malacea grows on mosses and plant remains on siliceous soils in the Alpine belt, and has a circumpolar-alpine distribution. In the Carnic Alps it is rare.

Peltigera neckeri Müll. Arg.

Carnic Alps: - M. Tinisa, 1700 m, on soil, 08.1982, leg. Loi (2702). - M. Brutto Passo, 1800 m, on soil, on sandstone, with *Calluna*, 16.09.1985, leg. N (6478). *Julian Alps*: - Foresta di Tarvisio, near Valbruna (UD), 1200 m, on soil on mosses, 20.11.1982, leg. N (2960).

This species is widespread from Scandinavia to the Mediterranean mountains and grows on base-rich soil. It belongs to the *P. polydactyla* group and its status has been recognized only by recent authors, so that its Italian distribution is still poorly understood.

Peltigera ponojensis Gyelnik

Carnic Alps: - Piz di Mede, 2000 m, on soil, on wind-swept ridge, 09.08.1986, leg. N (7686).

The Italian distribution of this species is badly-known. It has been reported only from Veneto, South Tyrol, but probably it could have been confused with the closely related *P. rufescens*.

Peltigera venosa (L.) Hoffm.

Carnic Alps: - Piz di Mede, 2000 m, on soil, in subvertical sandstone face, north exp., 09.08.1986, leg. N (7680). - M. Paularo, 1900 m, on soil, 10.08.1983, leg. N (3354). - M. Novarza, 1870 m, on mosses, in subvertical sandstone face, north exp., 11.09.1984, leg. N (4494). - Passo Volaja, near the lake, c. 2000 m, on mosses among the rocks, 29.09.1990, leg. T (14669).

P. venosa is a circumpolar-alpine species, of acid soil and mosses in humid sites. It is rather frequent in the Alps, but is also present, with isolated stations, along the Apennines.

Pertusaria coccodes (Ach.) Nyl.

Carnic Alps: - Passo Pura, 1050 m, near the road towards Sauris, 07.1979, leg. N, rev. T (1562).

Karst: - Lipica (Slovenia), 400 m, on *Quercus cerris*, 04.08.1989, leg. T & Castello (13299).

In the survey area this species is rather rare, and seems to be bound to more or less suboceanic climate conditions. The sample from Lipica, just a few kilometers from the Italian border, fits well with the description of the f. *phymatodes* (Ach.) Erichsen.

Pertusaria coronata (Ach.) Th. Fr.

Carnic Alps: - Passo Volaja, road from the Rif. Tolazzi, c. 1470 m, on bark of conifer, 28.09.1990, leg. T (15091). - Lago di Sauris, Bosco della Stua, c. 1050 m, on *Abies*, 26.09.1990, leg. N & T (15083). - Passo Pura, 1480 m, on *Fagus*, 09.08.1981, leg. De Faveri & N (1979). - Conca di Sauris, forests above Lateis, 1400 m, on *Fagus*, 07.08.1986, leg. N (7763). *Julian Alps*: - Rif. Grego, 1400 m, on *Fagus*, 20.11.1982, leg. N (2976).

P. coronata seems to be limited to Europe where it grows on broad-leaved trees, in wayside and woodland sites. In Friuli it is more frequent than *P. coccodes*, which is morphologically very similar, but has more regular, clavate isidia and a different chemistry. New to the Julian Alps.

***Pertusaria flavida* (DC.) Laundon**

Carnic pre-Alps: Bosco del Cansiglio, 1050 m, on *Fagus*, 13.04.1981, leg. de Faveri (1135).

Karst: - Ferneti, in a large dolina, 400 m, on *Quercus cerris*, 09.1983, leg. N, rev. T (3650). - Lipica (Slovenia), on *Quercus cerris*, 400 m, 04.08.1989, leg. T & Castello (13300). - Between Lokev and Divaca (Slovenija), c. 360 m, on *Quercus cerris*, in a large dolina, 14.04.1990, leg. T (13995).

P. flavida is widespread in warm-temperate areas of Europe and North Africa. In the Karst it is more common in the interior, on the bark of old, isolated *Quercus* trees. Along the Italian Peninsula it is rather common on old *Castanea* trees.

***Pertusaria leucostoma* (Bernh.) Massal.**

Julian Alps: - Laghi di Fusine, 1450 m, on *Fagus*, 23.07.1984, leg. N (4350). - Rif. Greco, 1400 m, on *Fagus*, 20.11.1982, leg. N (2982). *Julian pre-Alps*: - M. Matajur, near the Rif. Pelizzo, 1400 m, at the base of *Fagus*, 28.12.1982, leg. N (3046).

P. leucostoma has a wide pantemperate distribution in the Northern Hemisphere. It is common throughout Friuli, with a frequency maximum in the beech belt.

***Pertusaria pustulata* (Ach.) Duby**

Karst: - Aurisina, 170 m, on *Quercus petraea*, 05.03.1987, leg. N & T (8386).

This is an epiphytic species, occurring mainly in the deciduous forest belt. In Europe it has a subatlantic-mediterranean range, being absent from East Europe. New to the Karst area.

***Phaeocalicium compressulum* (Vainio) A. Schmidt**

Carnic Alps: - M. Brutto Passo, 1700 m, on twigs of *Alnus viridis*, 21.08.1983, leg. N (3413). - Passo Pura, 1440 m, on twigs of *Alnus viridis*, 08.1981, leg. N (3090). - Casera Razzo (BL), 1850 m, on *Alnus viridis*, 07.08.1986, leg. N (7756). - M. Crostis, 1700 m, on twigs of *Alnus viridis*, 05.09.1983, leg. N (3550). *Julian Alps*: - Foresta di Tarvisio, Valbruna, 1200 m, on twigs of *Alnus*, 20.11.1982, leg. N (3068). *Julian pre-Alps*: - M. Joanaz, 900 m, on *Alnus*, 11.09.1983, leg. N (3554).

This species grows on the young twigs of *Alnus viridis* in the upper montane-subalpine belts of the Alps. It is common, but has been certainly overlooked. Cited from the Carnic Alps by Clerc (1983).

***Phaeophyscia cernohorskyi* (Nádv.) Essl.**

Karst: - Val Rosandra, 200 m, on vertical calcareous faces, 27.12.1981, leg. Loi & N (2381). - Contovello, c. 180 m, on epilithic mosses (sandstone), 01.01.1989, leg. T (10932). - Near the S. Croce railway station, c. 120 m, on a sandstone wall, 23.03.1992, leg. T (16016).

P. cernohorskyi is a submediterranean species which is rather frequent, in the survey area, along the coast, on sandstone, where it forms large colonies.

***Phaeophyscia endococcina* (Körber) Moberg**

Carnic Alps: - M. Nedis (Paularo, UD), 1600 m, on siliceous rock, 06.01.1990, leg. Bersan (14069). - Casera Razzo (BL), 1730 m, on scists, 13.07.1981, leg. Fragiaco & N (1633).

P. endococcina grows on siliceous stones and epilithic mosses in the subalpine-alpine belts; it is distributed in the subboreal to cold-temperate zones of the

Northern Hemisphere. In our region this species is limited to the inner Carnic Alps, in rather dry, sunny situations. Schuler (1893) reported it from the Karst, but the specimens collected by him, and preserved in PAD, are epilithic forms of the sorediate *P. endophoenicea*.

Phaeophyscia endophoenicea (Harm.) Moberg

Karst: - Slivia (TS), near a large dolina along the road towards Visogliano, on epiphytic mosses (*Quercus*), 06.1991, leg. T (15976). - Malchina (TS), c. 200 m, on *Quercus*, 05.1988, leg. Castello (10594).

This lichen is distributed in southern and central Europe; it grows mainly on bark and mosses. The specimens from the Karst are usually very poorly-developed, and the species is certainly not common.

Phaeophyscia opuntiella (Poelt) Clauz. & Roux

Karst: - M. Grisa (TS), c. 150 m, on epilithic mosses (limestone), 06.1989, leg. N (15971).

This is a very inconspicuous lichen, which grows on epilithic mosses, other lichens and soil, in rather sunny sites. For Italy it was reported only from South Tyrol. New to the Karst.

Phaeophyscia sciastra (Ach.) Moberg

Carnic Alps: - Passo di M. Croce Carnico, 1300 m, on calcareous rock, 28.10.1982, leg. N (2883). - Piz di Mede, 2000 m, on mosses on sandstone, 09.08.1986, leg. N (7715). - Passo Volaja, 2000 m, on limestone, 07.08.1981, leg. De Faveri & N (1962).

Karst: - Bivio di Aurisina, near the railway station, 135 m, on cement wall, 01.06.1985, leg. N (5698).

P. sciastra is a nitrophytic lichen growing on a wide variety of substrata, which is rather common in the alpine belt. New to the region.

Phaeorrhiza nimbose (Fr.) H. Mayrh. & Poelt

Carnic Alps: - Malpasso del Tinisa (Passo Pura, UD), c. 2000 m, on plant remains on soil, in fissure, 17.08.1988, leg. T (10893). *Julian Alps*: - M. Lopa, 2250 m, on calcareous soil, 10.08.1981, leg. de Faveri & N, conf. H. Mayrh. (1775). - M. Lagna, 2000 m, on a calcareous ridge, 10.09.1984, leg. N (4565).

This species grows on plant remains and raw humus in the alpine belt, often also on calcareous soil. It has a broad, circumboreal-alpine distribution and is known also from the Southern Hemisphere.

Phlyctis agelaea (Ach.) Flotow

Carnic pre-Alps: - Bosco del Cansiglio, 650 m, on *Fagus*, 09.1981, leg. De Faveri & N (2802).

This epiphytic species is rather frequent in humid deciduous and evergreen forests of warm-suboceanic regions; in the survey area it is evidently rare, and has been collected only once. The small rounded apothecia covered by powder may resemble soralia, the absence of which separate this species from the more common *Ph. argena*.

Physcia biziana (Massal.) Zahlbr.

Friulian Plain: - Grado, 5 m, 09.05.1981, leg. De Faveri & Nimis (1404). - Mariano del Friuli, 34 m, on *Populus*, 20.06.1985, leg. N (5822).

P. biziana includes a series of different, closely related taxa, whose taxonomic position need a clarification. The species is very frequent in the Karst area, but in Friuli it is known only from the two localities reported above. Probably it is also present in submediterranean areas of the outer pre-Alps.

Physconia enteroxantha (Nyl.) Poelt

Karst: Doberdò del Lago, on *Ulmus*, 07.05.1988, leg. Castello (10592).

P. enteroxantha is a rather nitrophytic lichen of bark and siliceous rocks in rather humid sites. The specimen cited here is not well-developed, but has the typical yellow reaction of the medulla to K. New to the Karst.

Physconia muscigena (Ach.) Poelt

Carnic Alps: - Passo Volaja, near the Austrian refuge, 1950 m, on mosses on wind-swept ridge, 21.01.1989, leg. Bersan (14068). - Piz di Mede, 2000 m, on mosses on wind-swept ridge, 09.08.1986, leg. N (7711). - Passo Volaja, c. 2000 m, on west-exposed face, on mosses, 28.09.1990, leg. T (14676).

P. muscigena grows on plant remains and mosses in the alpine belt of the Alps, mainly on calcareous substrata. It is rather polymorphic and has an arctic-alpine, circumboreal range. It is common in the mountains of the survey area.

Physconia servitii (Nádv.) Poelt

Karst: - Basovizza, 450 m, on *Quercus*, 12.03.1988, leg. Castello (10138). - Gropada (Basovizza, TS), c. 360 m, on *Quercus*, near a dolina, 17.11.1992, leg. T (16645).

This species has a mediterranean-submediterranean distribution, and in Italy it is not uncommon below the montane belt. New to the region.

Physma omphalarioides (Anzi) Arnold

Karst: - Gropada (TS), c. 400 m, on an isolated, old *Q. pubescens*, 06.03.1990, leg. T (13725).

P. omphalarioides has a mediterranean-submediterranean distribution, but surprisingly it occurs also in the southern Scandinavia. Its spores have a well-developed episporium, similar to that of *Pannaria pezizoides* or *Psoroma hypnorum*. In the Karst it is very rare, but in PAD there are several specimens collected in Istria by Schuler.

Placynthium filiforme (Garov.) M. Choisy

Carnic Alps: - Between Timau and Passo di M. Croce Carnico, 1100 m, on limestone, vertical face south exp., 28.10.1982, leg. N (2866). *Friulian Plain*: - Bocche di Crosis (Tarcento, UD), 260 m, on limestone, 25.06.1985, leg. N (5906). *Julian pre-Alps*: - Above Ucea (Resia, UD), 700 m, on vertical calcareous face, 25.06.1985, leg. N (5905).

P. filiforme grows on calcareous faces, mainly in the montane belt, and is distributed from the Mediterranean to the central European regions. It was

erroneously reported by Nimis & Loi (1982, 1984) from the Karst area, where it is apparently absent.

Placynthium hungaricum Gyeln.

Carnic pre-Alps: - Claut (PN), 600 m, on limestone, 15.05.1983, leg. Loi (3318). *Julian pre-Alps*: - M. Glemina (Gemona, UD), 650 m, limestone, south exp., 08.06.1981, leg. De Faveri & N (1622).

Karst: - Val Rosandra, 150 m, on calcareous faces verticali, south exp., 27.02.1983, leg. N (3277). - Val Rosandra, 170 m, on calcareous face vertical, 02.02.1983, leg. N (3157).

This rather poorly-known species, characterized by the pruinose, lobate thallus, seems to be not uncommon on calcareous faces with periodical water seepage, especially in the Carnic and Julian pre-Alps.

Poeltinula cacuminum (Asta, Clauz. & Roux) Clauz. & Roux

Carnic Alps: - Passo Volaja, on limestone, c. 1950 m, 28.09.1990, leg. T (15413).

This rarely collected lichen grows on hard calcareous- dolomitic rocks in the alpine belt of the Alps. It is known from several localities in the Alps, but was not previously known from Italy. All characters fit well with the description; the species differs from the similar *P. cerebrina* in the spore pigmentation, and in the development of excipulum and paraphyses.

Polyblastia ardesiaca (Bagl. & Car.) Zsch.

Julian Alps: - Laghi di Fusine, 1700 m, on calcareous outcrops, 06.11.1983, leg. Palma (3747).

This lichen was rarely collected, and until now it is known only from a few localities in the Alps, on hard calcareous rocks in very humid sites.

Polyblastia cupularis Massal.

Carnic Alps: - M. Brutto Passo, 1950 m, on calcareous sandstone, 16.09.1985, leg. N (6471). *Julian Alps*: - Jof Fuart, 1900 m, on limestone, 07.11.1983, leg. Visintin (4022).

P. cupularis grows on rather shaded surfaces of limestone or calcareous sandstone, above the montane belt. Previously reported from the Julian Alps by Clerc (1984), it is new to the Carnic Alps.

Polyblastia helvetica Th. Fr.

Carnic Alps: - M. Novarza, c. 1870 m, on soil and mosses, 29.09.1990, leg. N & T (11315).

The identification of this sample is not certain. According to the description, the peritecia should be completely brown, while this sample, on the contrary, has colourless peritecia in the lower part. *P. helvetica* is hitherto known from the British isles, Scandinavia and the Alps, but it was not previously reported from Italy. The material was compared with an abundant collection from Greenland, preserved in GZU (Disko: Hänge unmittelbar N Godhavn, 20-50 m, gneiss, 07.1983, leg. J. Poelt & Ullrich).

Polyblastia ventosa Arnold

Carnic Alps: - M. Lagna, 1950 m, on limestone, 10.09.1984, leg. N (4593).

This species has been rarely collected, but it is not uncommon on calcareous rocks in exposed situations above tree limit. New to the region.

Polysporina simplex (Davies) Vezda

Carnic Alps: - Piz di Mede, 1600 m, on metamorphic sandstones, 08.08.1986, leg. N (7816).

Karst: - Contovello (TS), c. 160 m, sandstone, 26.12.1988, leg. T (10948).

P. simplex is a pioneer lichen of siliceous rocks or decalcified sandstone; its distribution encompasses both Hemispheres. It was previously reported from the Karst area by Schuler (1893).

Porina aenea (Wallr.) Zahlbr.

Friulian Plain: - Tarcento (UD), 350 m, on *Carpinus*, 10.1978, leg. N (2899). - Borgo Meduno (PN), 06.12.1982, leg. Loi (3164). *Julian pre-Alps*: - Tramonti di Sotto, on *Fraxinus ornus*, 14.10.1983, leg. N (3660).

This species has a more or less holarctic distribution in the Northern Hemisphere, and grows mainly on the smooth bark of deciduous trees, such as *Carpinus*, *Fraxinus* and *Fagus*.

Porina chlorotica (Ach.) Müll. Arg.

Carnic Alps: - M. Crostis, c. 1900 m, on siliceous rock (schist), in shadow, 08.1986, leg. N (11689).

This cosmopolitan lichen grows on siliceous rocks in shaded and humid situations, and is not common. New to the region.

Porina mammillosa (Th. Fr.) Zahlbr.

Carnic Alps: - M. Paularo, on epigeaeic mosses, on acid soil, c. 1950 m, 29.09.1990, leg. T, rev. J. Poelt (16654).

P. mammillosa grows on mosses and plant remains, on acid soil, and in Europe has a boreal-montane distribution. For Italy there was only a single record from Piedmont of the previous century. New to the region.

Porpidia crustulata (Ach.) Hertel & Knoph

Carnic Alps: - M. Chiadin, 1800 m, on small siliceous pebbles on the soil, 13.11.1983, leg. M. Palma, rev. T (3809).

This is a pioneer lichen which grows mainly on small siliceous pebbles. It is rather frequent in the Alps, but it was not previously reported from Friuli.

Protoblastenia terricola (Anzi) Lynge

Carnic Alps: - Passo Pura, Malpasso del Tinisa (UD), on calcareous soil and plant remains, c. 2000 m, 12.08.1988, leg. T (10894). - Passo Volaja (UD), on calcareous soil and mosses, c. 1950 m, 28.09.1990, leg. T (15414).

This lichen grows on soil, on weakly calcareous parent material, in the alpine belt, and has an arctic-alpine distribution. New to the region.

Protoparmelia badia (Hoffm.) Haf.

Carnic Alps: - M. Novarza, c. 1900 m, on sandstone, 30.09.1988, leg. Castello, rev. T (12221).

This is a rather common lichen of base-rich siliceous rocks, with a wide altitudinal range. New to the region, where it is not rare in the inner Carnic Alps.

Protoparmelia badia v. cinereobadia (Harm.) Clauz. & Roux

Carnic Alps: - M. Paularo, 1950 m, on siliceous rocks, 29.09.1990, leg. T (15100).

This variety is quite rare; it was collected only once, together with specimens of *P. badia* s. str. It is new to Italy.

Pseudephebe pubescens(L.) M. Choisy

Carnic Alps: - M. Crostis, 2000 m, on siliceous rock, on wind-swept ridge, 05.09.1983, leg. N (3494). - Piz di Mede, 2000 m, on sandstone, on a ridge, 09.08.1986, leg. N (7683).

This species has a bipolar distribution, and grows on siliceous rocks, often on pure quartz, in wind-swept ridges. New to the region.

Psora decipiens (Hedw.) Hoffm.

Carnic Alps: - M. Coglians, above the rif. Marinelli, 1300 m, on soil, 13.11.1983, leg. Palma (3797). - M. Chiadenis, 2400 m, on soil, 25.09.1983, leg. Palma (3640). - M. Paularo, c. 1950 m, on acid soil, 29.09.1990, leg. T (15434). *Julian Alps*: - M. Canin, 1820, on soil, 21.09.1978, leg. Lausi, det. N (290).

This is a very common species, which grows directly on soil and plant remains, from the alpine to the mediterranean belts, mainly on calcareous substrata.

Psoroma hypnorum (Vahl) Gray

Carnic Alps: - Passo Volaja (UD), on terricolous mosses, c. 2000 m, 28.09.1990, leg. T (14750). - Piz di Mede, 2000 m, on epilithic mosses (sandstone), 09.08.1986, leg. N (7719). *Julian Alps*: - M. Canin, 2000 m, on mosses, 28.07.1983, leg. Zuccarello, rev. T (3350).

This species grows on soil and mosses in humid habitats, on both calcareous and siliceous rocks. It has a wide, holarctic and bipolar distribution. In the region it is not frequent.

Pycnothelia papillaria Dufour

Carnic Alps: - M. Tenchia (Cercivento, UD), 1800 m, on soil, 26.06.1988, leg. Bersan (10658). - M. Paularo, 2000 m, on ranker, 16.08.1981, leg. N (1703). - M. Zoufplan, 1950 m, on soil, 19.02.1989, leg. Bersan (12273). - M. Chiadin, 1900 m, on soil, 13.11.1983, leg. Palma (3795). - Piz di Mede, 2000 m, on soil, 09.08.1986, leg. N (7677). - M. Crostis, 1900 m, on soil, 05.09.1983, leg. N (3504).

P. papillaria grows on soil deriving from acid substrata and is widespread, but not common throughout Italy. In the survey area it is particularly common in *Calluna*-stands, also in the Julian pre-Alps with siliceous substrata (sandstone), where the species was observed several times, but never collected. New to the region.

Pyrenula nitida (Weigel) Ach.

Carnic Alps: - Lateis (UD), 1150 m, on *Fagus*, at the base of the trunk, in *Abieti - Fagetum*, 12.09.1984, leg. N (4485). - Lago di Sauris, Bosco Flobia, above Rio Storto, c. 1150 m, on *Fagus*, 13.09.1991, leg. T (15378). - Passo Pura, 1440 m, at the base of *Fagus*, 08.1982, leg. N (3044). *Julian Alps*: - Laghi di Fusine, 1450 m, on *Abies*, 23.07.1984, leg. N (4346). *Julian pre-Alps*: - M. Matajur, 1300 m, at the base of *Fagus*, 28.12.1982, leg. N (3042).

Pyrenula nitida, which grows on smooth bark (mostly *Fagus*) in rather shaded situations, is restricted to Europe. It is not common in the beech forests of the eastern Alps.

Ramalina obtusata (Arnold) Bitter

Carnic Alps: - Pierabech (Forni Avoltri, UD), 970 m, on *Abies alba*, 30.09.1986, leg. N (7885). - Lago di Sauris, 970 m, on *Salix*, 08.08.1981, leg. De Faveri & N 1739).

This species is quite rare in the survey area. It has an eastern, boreal range, and grows on twigs of *Picea* and *Abies* in moist montane and subalpine forests.

Ramalina pollinaria (Westr.) Ach.

Carnic Alps: - Passo Pura, Bosco della Stua, 1100 m, on *Fagus*, 11.09.1987, leg. N & T.

Very polymorphic, *R. pollinaria* grows both on bark and on rocks, also on limestone. It is rare in the survey area.

Ramalina thrausta (Ach.) Nyl.

Carnic Alps: - Between the lake of Sauris and Passo Pura, 1200 m, on *Fagus*, *Abies* and *Picea*, 09.08.1981, leg. De Faveri & N (1757). - Passo Pura, 1440 m, on *Larix*, 18.08.1979, leg. N (769). - Above Lateis (UD), 1350 m, on *Abies*, 08.08.1986, leg. N (7808).

This is an epiphytic species which grows in montane, humid woods. In the survey area it is restricted to *Abieti-Fagetum* forests, and is rather rare.

Rhizocarpon badioatrum (Sprengel) Th. Fr.

Carnic Alps: M. Paularo, above the lake, c. 1900 m, on siliceous rock, 29.09.1990, leg. T (15097).

Rh. badioatrum is an arctic-alpine to boreal-montane species of siliceous rocks. The specimen from M. Paularo has a well-developed, squamulose thallus. New to the region.

Rhizocarpon carpaticum Runem.

Carnic Alps: - M. Crostis, 1900 m, on schists in a niche, 08.1986, leg. N (11690).

This species was previously known only from two other Italian localities, in South Tyrol and Veneto. It grows on underhanging surfaces of siliceous rocks in wind-exposed sites, in the alpine belt.

Rhizocarpon geminatum Körber

Carnic Alps: - M. Neddís (Paularo, UD), 1800 m, on siliceous rock, 02.1990, leg. Bersan (13637).

Rh. geminatum grows mainly on base-rich siliceous rocks, and has a holarctic distribution. In Italy it is known from many localities in the Alps, and from Sardinia. In the Carnic Alps it is not common.

Rhizocarpon hochstetteri (Körber) Vainio

Carnic Alps: - M. Neddis (Paularo, UD), 1600 m, on siliceous rock, 06.01.1990, leg. Bersan (14082).

There are only a few records of *R. hochstetteri* from Italy (Sardinia and Sicily), but the species should be more common in the Italian Alps. It has a boreal-montane distribution and it grows on base-rich siliceous substrata.

Rhizocarpon lecanorinum Anders

Karst: - Conconello, 150 m, on sandstone wall, on an horizontal face, 12.12.1979, leg. N (886). - Contovello, near the cemetery, 250 m, on sandstone, north exp., 28.11.1988, leg. T (16792).

This silicicolous and rather nitrophytic species occurs below the subalpine belt and has a boreal-temperate distribution in the Northern Hemisphere. It is not uncommon in the Mediterranean mountains, and is apparently rather rare in the survey area.

Rhizocarpon obscuratum (Ach.) Massal.

Carnic Alps: - M. Lagna, 1850 m, on sandstone, 10.09.1984, leg. N (4578). - M. Crostis, 1800 m, on sandstone, 05.09.1983, leg. N (3538). - Pic Chiadin, 1950 m, on siliceous rock, 13.11.1983, leg. Palma (3817). - M. Dimon, 1900 m, on sandstone, 10.09.1983, leg. N (3684). - Passo Pramollo, 1600 m, on small pebbles on soil, 25.11.1983, leg. Palma (3837). - M. Zoufplan, 1900 m, on siliceous rock, 19.02.1989, leg. Bersan (12806). - Timau, 830 m, on siliceous rock, 27.07.1988, leg. Bersan (10762).

This is a rather variable, cosmopolitan lichen of siliceous rocks near the soil surface. It is frequent in the subalpine belt of the Carnic Alps. The distinction from *Rh. lavatum* is not clear to me.

Rhizocarpon oederi (Weber) Körber

Carnic Alps: - Passo Cason of Lanza, 1550 m, on siliceous rock, 23.07.1984, leg. N (4366).

This species is quite rare throughout its range, and grows on metal-rich siliceous rocks in humid situations. The specimen cited here fits well with other samples preserved in TSB, but it is sporeless and not well-developed.

Rhizocarpon petraeum (Wulfen) Massal.

Carnic Alps: - High Pesarina valley, 1400 m, on sandstone, 03.09.1983, leg. N (3517).

This lichen grows on rather calcareous substrata such as Flysch and sandstone, or on base-rich siliceous rocks. In northern Italy it is rather common, but it was not previously reported from Friuli.

Rhizocarpon polycarpum (Hepp) Th. Fr.

Carnic Alps: - M. Crostis, 1850 m, on sandstone, 05.09.1983, leg. N (3508). - Passo Pramollo, 1600 m, on small, siliceous pebbles on soil, 25.11.1983, leg. Palma (3836). - M. Tenchia, 1850 m, on siliceous rock, 26.06.1988, leg. Bersan (12812). - M. Novarza, 1870 m, on sandstone, 11.19.1984, leg. N (4499).

Rh. polycarpum has a boreal-montane range and is known from many localities of the Alps. New to Friuli, where it is not uncommon in upland areas.

Rhizocarpon ridescens (Nyl.) Zahlbr.

Carnic Alps: - Passo Pramollo, M. Carnizza, c. 1620 m, on roccia conglomeratica quarzifera, 29.05.1989, leg. Bersan & Codogno (12311).

This sorediate species has a scattered distribution in Europe. For Italy it was previously known only from a single locality in South Tyrol.

Rhizocarpon umbilicatum (Ramond) Flagey

Carnic Alps: - M. Novarza, 1870 m, vertical face arenacea, north exp., 11.08.1984, leg. N (4473). - M. Tinisa, 1600 m, on limestone, 08.1981, leg. N (2722). - Passo di M. Croce Carnico, 1300 m, on sandstone, 28.10.1982, leg. N (2872). - Lateis (UD), above C.ra Novarzutta, 1730 m, on sandstones, 28.09.1988, leg. T (10892). *Julian Alps*: - M. Lopa, 2250 m, on limestone, 10.08.1981, leg. De Faveri & N (1766).

Rh. umbilicatum is the only member of the genus growing on calciferous rocks, from the montane to the subalpine belt. It has a wide distribution in the Northern Hemisphere, and is rather common in the Alps and the Mediterranean mountains.

Sacomorpha uliginosa (Schrader) Haf.

Carnic Alps: - M. Paularo, 1950 m, on windy ridge, on soil, 29.09.1990, leg. T (15095). - Piz di Mede, 2000 m, on lignum on soil, 09.08.1986, leg. N (7727).

This is a common species which grows on raw humus on acid soil; in Italy it seems to be restricted to the north and the central part of the Peninsula.

Sagiolechia protuberans (Ach.) Massal.

Carnic Alps: - Passo Pura, 1400 m, on shaded calcareous rocks, 05.09.1983, leg. N (3479). *Julian Alps*: - Foresta di Tarvisio, above Valbruna, 1300 m, on calcareous boulder in a beech forest, 20.11.1982, leg. N (2961).

This species grows on calcareous rocks in shaded situations, and is rather rare. New to the region.

Sarea resinae (Fr.) Kuntze

Carnic Alps: - Lateis (Sauris, UD), road towards C.ra Novarzutta, c. 1350 m, on *Larix decidua*, 12.09.1991, leg. T & N (15373).

This is a non-lichenized fungus growing on the resin of conifers, mainly *Larix*; it has probably a boreal-montane distribution. For Italy there were only old records from South Tyrol, Piedmont, Lombardy and Tuscany. New to Friuli.

Scoliciosporum pruinosum (P. James) Vezda

Karst: - Between Basovizza and the Italian border, c. 380 m, on *Q. cerris*, in the bark fissures, 29.03.1992, leg. T (16017).

This is an apparently rare *Scoliciosporum* which is characterized by a pulverulent, whitish-green thallus, and by pale apothecia with well-developed crystals in the epithecium. The same species was also collected in Slovenia, in a large dolina between Lokev and Divaca (13994), near the border. New to Italy.

Solorina bispora Nyl.

Carnic Alps: - Piz di Mede, 2000 m, 09.08.1986, leg. N (7740). - Passo Pura, on soil, c. 1800 m, 12.08.1988, leg. T (10852). - Val Cimoliana, Cimolais, 650 m, on calcareous soil, 25.08.1985, leg. Loi (6403). - M. Brutto Passo, 1700 m, on soil, on a crust of *Gloeocapsa*, 21.08.1983, leg. N (3418). - M. Chiadenis, 2400 m, on soil, 25.09.1983, leg. Palma (3644). - M. Tiarfin, 2200 m, on calcareous soil, 20.09.1981, leg. Loi & N (2021). - Rivoli Bianchi of Tolmezzo, 600 m, on limestone, 08.06.1981, leg. N & De Faveri (1569). - M. Paularo, 2000 m, on ranker, 16.08.1981, leg. N (1730). *Julian Alps*: - M. Montasio, 1500 m, on soil, 07.1979, leg. De Faveri & N (1351). - M. Canin, above Sella Nevea, 1850 m, on soil in seslerieto, 07.1980, leg. De Faveri & N (1226). - Jof Fuart, 2300 m, on calcareous rocks, 04.09.1981, leg. Lausi & Moschitz (2810). - M. Lopa, 2250 m, on calcareous soil, 10.08.1981, leg. De Faveri & N (1774).

This is a common macrolichen of calciferous substrata, which is particularly frequent in the subalpine-alpine belts. The closely related *S. spongiosa*, with 4-spored asci, contains both green algae and cynaobacteria. Also the specimens 1774 and 7740 are photosymbiodemes, but the asci are bisporous.

Solorina crocea (L.) Ach.

Carnic Alps: - Piz di Mede, 2000 m, on soil, on acid substratum, in *Rhodoro - vacciniatum*, on a wind-swept ridge, 09.08.1986, leg. N (7702). - M. Zoufplan, 1950 m, on soil, 19.02.1989, leg. Bersan (11657).

S. crocea grows on soil and acid substrata in the subalpine-alpine belts and has an arctic-alpine distribution. In the survey area it was found only in the inner Carnic Alps. New to the survey area.

Sporastatia testudinea (Ach.) Massal.

Carnic Alps: - M. Chiadin, 1900 m, on sandstone, 13.11.1983, leg. Palma (3794). - M. Crostis, 2000 m, on siliceous rock, north exp., 05.09.1983, leg. N, rev. T (3585).

This species has a large distribution, encompassing several mountain areas in both Hemispheres. It grows on siliceous rocks on steeply inclined, exposed surfaces. New to the survey area.

Squamarina lamarckii (DC.) Poelt

Carnic Alps: Passo M. Croce Carnico, c. 1800 m, on limestone, leg. De Bernardi (15098).

S. lamarckii grows on vertical, exposed surfaces of calcareous rocks in the subalpine-alpine belts of the central and southern European mountains. It was previously reported by Clerc (1984) from Passo Pura (Carnic Alps).

Squamarina periculosa (Duf.) Schaerer

Karst: - Val Rosandra, in rock fissures, 27.12.1981, leg. Loi & N (2378). - Val Rosandra, 170 m, vertical calcareous rock, north exp., 19.07.1979, leg. N (763).

This species grows in rock fissures or directly on calcareous rocks, from the Mediterranean region to the southern Alps. In the survey area it was collected only in the Rosandra Valley.

Thyrea girardii (Dur. & Mont.) Bagl. & Car.

Julian pre-Alps: - Ciseriis of Sotto (Tarcento, UD), 350 m, on vertical calcareous face, 05.12.1982, leg. N (2995).

This is a widespread species, which seems to be less frequent in upland areas than the previous one. New to the region.

Tomasellia arthonioides (Massal.) Massal.

Julian pre-Alps: - Bocche di Crosis, 250 m, on *Fraxinus ornus*, 26.06.1985, leg. N (5848).

This species has a submediterranean distribution in Europe, and grows mainly on the smooth bark of *Fraxinus ornus*. New to the survey area.

Trapelia coarctata (Sm.) M. Choisy

Karst: - Near Filtri di Aurisina, 80 m, on sandstone wall, 02.11.1987, leg. N (9891). - Contovello, c. 160 m, in shadow, on sandstone, near the ground, 01.01.1989, leg. T (10951).

T. coarctata has a very broad distribution, and grows on siliceous, subneutral rocks in rather humid situations. New to the survey area.

Trapelia involuta (Taylor) Hertel

Carnic Alps: - Lateis (UD), above C. ra Novarzutta, c. 1730 m, on pebbles on the ground, along the trail, 28.09.1988, leg. N, rev. T (10887).

T. involuta has a subatlantic distribution in Europe, and grows mainly on siliceous rocks, very often on pebbles near the soil. In the survey area it has been certainly overlooked.

Trapelia placodioides Coppins & P. James

Karst: - Contovello, c. 180 m, on a sandstone wall, near the soil, 01.01.1988, leg. T, vdt. Poelt (10938).

This sorediate species is not very frequent and, until now, it is known from scattered localities in Europe and Canada and it is new to Italy. It grows on siliceous substrata, and has been collected also on walls. The specimen is poorly-developed and not fruiting; the specimen was compared with Vezda, Lich. Sel. Exs. n. 2423.

Tremolecia atrata (Ach.) Hertel

Carnic Alps: - M. Paularo, c. 2000 m, siliceous rocks, north exp., 29.09.1990, leg. T (15933). - M. Paularo, 2000 m, on schist, 16.08.1981, leg. N (1722). - M. Crostis, 1950 m, on siliceous rock, 05.09.1983, leg. N (3587). - Passo Cason of Lanza, 1550 m, on siliceous rock, 23.07.1984, leg. N (4359). - Piz di Mede, 2000 m, on sandstone, 09.08.1986, leg. N (7707). - M. Chiadin, 1900 m, on sandstone, 13.11.1983, leg. Palma (3788). - Passo Pramollo, 1600 m, on siliceous rock, 25.11.1983, leg. Palma (3840).

In Italy this species is present throughout the Alps, but was never reported from the survey area. It grows on siliceous rocks, very often on metamorphic substrata, and is rather common in the inner Carnic Alps.

Usnea longissima Ach.

Carnic Alps: - Lago di Sauris, Bosco della Stua, 1100 m, on *Picea*, 08.1986, leg. T (9723). - Lago di Sauris, Bosco della Stua, 1000 m, on *Abies alba*, 07.08.1986, leg. N (7783).

Usnea longissima is one of the rarest epiphytic macrolichens of the Alps. It grows in natural moist forest in the montane belt, and presently it is in danger of extinction. This is the only recent record from the Italian Alps, and it refers to a small population surviving on a few conifers above the lake of Sauris.

Xanthoria sorediata (Vainio) Poelt

Julian Alps: - Jof Fuart, 2500 m, on limestone, 21.08.1983, leg. Visintin (3432). - M. Ponze, 1800 m, on limestone, 06.11.1983, leg. Palma (3731). - Jof Fuart, 2500 m, on mosses on calcareous soil, 21.08.1983, leg. Visintin (3326).

This species has an arctic-alpine distribution and grows on nutrient-enriched surfaces, on both siliceous and calcareous rocks. For Italy it is known only from a few stations, but it should be not uncommon in the subalpine-alpine belts of the Alps.

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EPIPHYTIC LICHENS FROM IBERIAN PARAMERAE. I. JAVALAMBRE MOUNTAINS (TERUEL, SPAIN)

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Vicent CALATAYUD & Eva BARRENO

Keywords: Epiphytic lichens, Chorology, Teruel, Spain, Iberian Paramerae.

Summary: A preliminary list of 61 epiphytic lichens from the Javalambre mountains (Teruel, Spain) is presented. The following phorophytes were sampled *Pinus sylvestris*, *P. nigra*, *Juniperus sabina*, *J. phoenicea*, *J. communis* subsp. *hemisphaerica*, and *J. thurifera*, in the *Sabino-Pineto sylvestris* and *Junipereto hemisphaerico-thuriferae* communities. 35 taxa are new to the Teruel country. *Aspicilia mutabilis* (Ach.) Körber, *Banhegya setispora* Zeller & Toth, *Caloplaca stillicidiorum* (Vahl) Lynge, *Caloplaca ulcerosa* Coppins & P. James, *Catinaria montana* (Nyl.) Vainio, *Letharia vulpina* (L.) Hue and *Thelenella modesta* (Nyl.) Nyl. are among the more significative species from the phytogeographical point of view.

Resumen: Se presenta un avance del catálogo de líquenes epifitos sobre *Pinus sylvestris*, *P. nigra*, *Juniperus sabina*, *J. phoenicea*, *J. communis* subsp. *hemisphaerica*, y *J. thurifera* en comunidades de dos series de vegetación basófilas: la oromediterránea maestrazgo-conquense de la sabina rastrera (*Sabino-Pineto sylvestris*) y la supramediterránea maestrazgo-ibérico-alcarreña de la sabina albar (*Junipereto hemisphaerico-thuriferae*) de la sierra de Javalambre (Teruel, España). De los 61 táxones líquénicos catalogados 35 representan nuevas citas para la provincia de Teruel. *Aspicilia mutabilis* (Ach.) Körber, *Banhegya setispora* Zeller & Toth, *Caloplaca stillicidiorum* (Vahl) Lynge, *Caloplaca ulcerosa* Coppins & P. James, *Catinaria montana* (Nyl.) Vainio, *Letharia vulpina* (L.) Hue y *Thelenella modesta* (Nyl.) Nyl., son algunos de los táxones más significativos desde el punto de vista fitogeográfico.

Introduction

This study is part of a broader project on the biodiversity of Iberian Paramerae, with particular regard to their lichen flora. Here we present the first results of a survey of epiphytic lichens occurring on the more representative phorophytes of the Javalambre mountains, which were never studied before by lichenologists.

The survey area is located in the southern part of Teruel country, bordering the provinces of Valencia (close to "Rincon de Ademuz"), Cuenca and Castellón (Fig. 1). These mountains are the southeasternmost extensions of the Iberian Chain, and are the most important high plateau south of the Mijares river. The prevailing geological substratum is Triassic and Cretaceous limestone, but there are also outcrops of marls, gypsum-rich marls and gypsum, with a predominance of basic substrata.

The main summits range from 1200 to 2020 m, the highest peaks being the

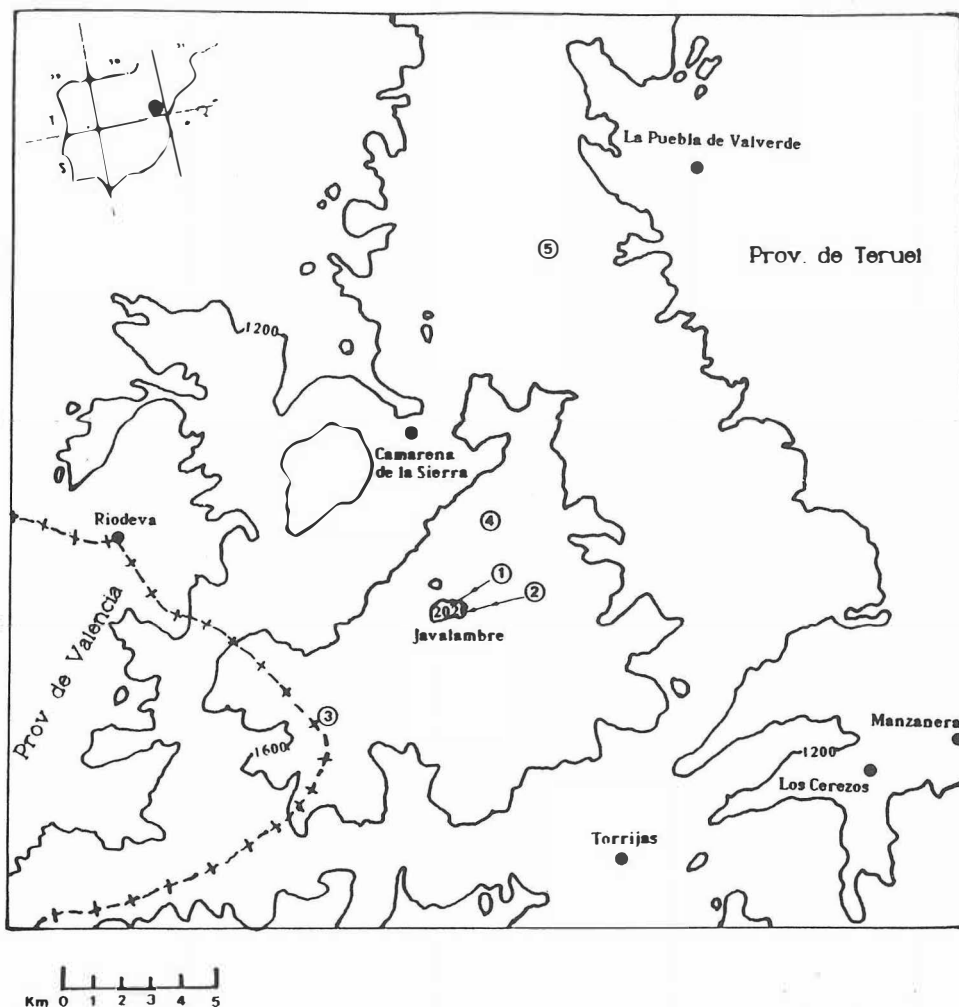


Fig. 1: Study area with sampled localities.

Upper Javalambre Mt. (2020 m), Javalambre Mt. (1985 m) and the Calderon Mt. ("Rincón de Ademuz" 1836 m). These mountains have a continental character, in spite of their being close to the sea (80 Km), and are dominated by a coniferous woodland with *Pinus sylvestris* L., *Pinus nigra* Arnold subsp. *salzmannii* (Dunal) Franco, and, in a lower layer, with *Juniperus sabina* L. and *Juniperus communis* L. subsp. *hemisphaerica* (J. & K. Presl.) Nyman.

There are no meteorological data on the survey area (Aguilella 1988), and those of neighbouring stations (Sarrión, Arroyo Cerezo) are of little use, due to

the different situation; however, the analysis of the flora and vegetation can furnish some bioclimatic information. According to Rivas-Martínez (1987), the vegetation of the summits of the Javalambre mountains pertains to the *Sabino-Pineto sylvestris* community (see also Rivas-Goday & Borja 1961). At lower altitudes there are open forests dominated by the Spanish juniper (*Juniperus thurifera* L.) and the common juniper (*Juniperus communis* L. subsp. *hemisphaerica*) *Junipereto hemisphaerico-thuriferae*, which a dense shrubby formation which is replaced by grasslands after disturbance, the latter usually with *Festuca hystrix* and *Poa ligulata*. From the phytogeographical point of view both formations belong to the Mediterranean-Iberolevantine Superprovince, Castellano-Maestrazgo-Manchega Province, Maestracense sector (Rivas-Martínez, 1987).

Material and Methods

The observed localities are listed below, with the elevation and the UTM coordinates:

- 1.Hs, TERUEL: Puebla de Valverde, Cerro de Javalambre, 30TXK684406, 2020 m.
 - 2.Hs, TERUEL: Puebla de Valverde, Alto del Ventisquero, 30TXK693414, 1900 m.
 - 3.Hs, TERUEL: Camarena de la Sierra, Refugio ICONA, 30TXK6439, 1750 m.
 - 4.Hs, TERUEL: Puebla de Valverde, Alto del Ave, 30TXK700440, 1700 m.
 - 5.Hs, TERUEL: Puebla de Valverde, Masia los Enebrales, 30TXK716528, 1250 m.
- Nomenclature follows Poelt (1969), Poelt & Vezda, (1977, 1981), Hafellner (1984), and Eriksson & Hawksworth (1986, 1987, 1988 and 1989); furthermore, we have consulted Santesson (1984), Hawksworth & al. (1980) and Cannon & al. 1985), and some Floras and catalogues of Mediterranean areas such as Clauzade & Roux (1985) and Nimis & Poelt (1987), and several recent monographs of different groups.

In the catalogue the species are listed in alphabetical order and the numbers of localities are indicated. The phorophytes are abbreviated as follows: Ps (*Pinus sylvestris*), Jh (*Juniperus hemisphaerica*), Jth (*Juniperus thurifera*), Js (*Juniperus sabina*). Also, we mark with * taxa which are new to the Teruel province and with ** those which are new to the Iberian Peninsula. Reference collections have been deposited at the VAB-LICH. Herbarium.

Results (species list)

- Anaptychia ciliaris* (Ach.) Körber - Loc.: 3,4,5. Ps, Js, Jth.
 * *Aspicilia mutabilis* (Ach.) Körber - Loc.: 2,5. Jh, Js, Jth.
 * *Arthonia radiata* (Pers.) Ach. - Loc.: 3. Ps.
 * *Bacidia naegelia* (Hepp) Zahlbr. - Loc.: 3,5. Ps, Jth.
 ** *Banhegya setispora* Zeller & Toth - Loc.: 2. Js.
 * *Bryoria fuscescens* (Gyeln.) Brodo & D. Hawksw. - Loc.:3. Ps.
Caloplaca cerina (Ehrh. ex Hedw.) Th. Fr. - Loc.: 2,3,4,5. Jh, Js, Ps, Jth.

- Caloplaca cerinella* (Nyl.) Flagey - Loc.: 1. Jh.
- * *Caloplaca cerinelloides* (Erichs) Poelt ined. - Loc.: 1 Jh.
 - * *Caloplaca ferruginea* (Huds.) Th. Fr. - Loc.: 2,3,4. Ps, Jh.
 - Caloplaca haematites* (Chaub. ex St.-Amans) Zwackh - Loc.: 2,3. Ps, Jh.
 - * *Caloplaca holocarpa* (Hoffm.) Wade - Loc.: 1,2,3,4. Ps, Jh, Js.
 - * *Caloplaca pollinii* (Massal.) Jatta - Loc.: 2,4. Ps, Js.
 - * *Caloplaca stillicidiorum* (Vahl) Lynge - Loc.: 5. Jth.
 - * *Caloplaca ulcerosa* Coppins & P. James - Loc.: 5. Jth.
 - * *Candelariella vitellina* (Ehrh.) Müll. Arg. - Loc.: 2,3. Jh, Js.
 - * *Candelariella xanthostigma* (Ach.) Lettau - Loc.: 2,3. Ps, Jh, Js.
 - * *Catillaria chalybeia* (Borrer) Massal. - Loc.: 2,3,4,5. Ps, Jh, Js, Jth.
 - * *Catillaria nigroclavata* (Nyl.) Schuler - Loc.: 2,3,4,5. Ps, Jh, Js, Jth.
 - * *Catinaria montana* (Nyl.) Vainio - Loc.: 4. Ps.
 - Cetraria chlorophylla* (Willd.) Vainio - Loc.: 2, 4. Ps, Jh.
 - * *Cladonia pyxidata* (L.) Hoffm. - Loc.: 2, 4. Ps, Jh, Js.
 - * *Collema subflaccidum* Degel. - Loc.: 3. Ps.
 - * *Hyperphyscia adglutinata* (Flörke) Mayrhofer & Poelt - Loc.: 5. Jth.
 - Hypogymnia bitteriana* (Zahlbr.) Räsänen - Loc.: 3,4. Ps.
 - * *Hypogymnia tubulosa* (Schaerer) Havaas - Loc.: 3,4. Ps.
 - Lecanora carpineae* (L.) Vainio - Loc.: 3,4. Ps, Js.
 - Lecanora chlorotera* Nyl. - Loc.: 1,2,3,4,5. Ps, Jh, Js, Jth.
 - * *Lecanora sienae* B. de Lesd. - Loc.: 1,2,3,4,5. Ps, Jh, Js, Jth.
 - * *Lecidella achrostotera* (Nyl.) Hertel & Leuckert - Loc.: 1,2,3,4,5. Ps, Jh, Js, Jth.
 - Lecidella elaeochroma* (Ach.) M. Choisy - Loc.: 1,2,3,4,5. Ps, Jh, Js, Jth.
 - * *Lecidella euphorea* (Flörke) Hertel - Loc.: 1,2,3,4,5. Ps, Jh, Js, Jth.
 - * *Leptogium teretiusculum* (Wallr.) Arnold - Loc.: 2. Jh.
 - Letharia vulpina* (L.) Hue - Loc.: 3. Ps.
 - * *Mycocalicium parietinum* (Ach. ex Schaerer) Hawksworth - Loc.: 5. Jth.
 - * *Ochrolechia szatalaensis* Vers. - Loc.: 4. Ps, Jh, Js, Jth.
 - * *Ochrolechia turneri* (Sm.) Hasselrot - Loc.: 3,4. Ps.
 - Parmelia acetabulum* (Necker) Duby - Loc.: 3,4. Ps, Js, Jth.
 - Parmelia exasperata* de Not. - Loc.: 3,4. Ps, Js, Jth.
 - Parmelia exasperatula* Nyl. - Loc.: 3,4. Ps, Js, Jth.
 - * *Parmelia incolorata* (Parr.) Lettau - Loc.: 4. Ps, Jh.
 - * *Parmelia laciniatula* (Flagey ex Olivier) Zahlbr. - Loc.: 4. Ps.
 - * *Parmelia saxatilis* (L.) Ach. - Loc.: 3,4. Ps.
 - * *Parmelia sulcata* Taylor - Loc.: 3. Ps.
 - Parmelia tiliacea* (Hoffm.) Ach. - Loc.: 3. Ps.
 - * *Parmeliopsis ambigua* (Wulfen) Nyl. - Loc.: 3. Ps.
 - Physcia adscendens* (Fr.) Olivier - Loc.: 3,4. Ps, Jh, Js, Jth.
 - Physcia aipolia* (Ehrh.) Fűrnröhr - Loc.: 4. Ps, Jh, Js, Jth.
 - Physcia biziana* (Massal.) Zahlbr. - Loc.: 1,2. Jh.

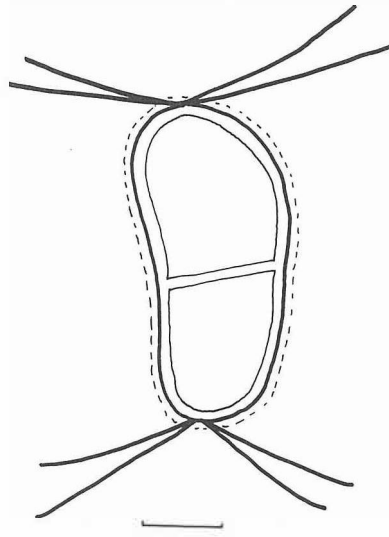


Fig. 2: *Banhegyia setispora* VAB-LICH. 5065. A mature ascospore with setose ends . Scale = 5 μ m.

Physcia semipinnata (Gmelin) Moberg - Loc.: 4. Ps, Jh, Js, Jth.

Physconia venusta (Ach.) Poelt - Loc.: 4. Ps.

Platismatia glauca (L.) W. Culb & C. Culb. - Loc.: 3,4. Ps.

Pseudevernia furfuracea (L.) Zopf - Loc.: 3,4. Ps, Jh, Js.

* *Pyrrhospora quernea* (Dickson) Körber - Loc.: 3. Ps.

Ramalina farinacea (L.) Ach. - Loc.: 3. Ps.

Ramalina fraxinea (L.) Ach. - Loc.: 4. Ps.

* *Rinodina archaea* (Arnold) Arnold - Loc.: 3,4. Ps, Jh, Js, Jth.

Thelenella modesta (Nyl.) Nyl. - Loc.: 3. Ps, Jth.

* *Usnea hirta* (L.) Web. ex Wigg. - Loc.: 3. Ps.

Xanthoria parietina (L.) Th. Fr. - Loc.: 3. Ps, Js, Jth.

* *Xanthoria polycarpa* (Hoffm.) Rieber - Loc. 5. Jth.

Discussion

Crustose species are 50% of the total, with a prevalence of species of nutrient-rich bark, such as some *Teloschistaceae*; these are more abundant over junipers and savins at high elevations, where cattle raising is common. Fruticose lichens such as *Usnea*, *Ramalina*, *Bryoria*, *Pseudevernia* are rare at high altitudes, perhaps because of the relatively dry climate; *Anaptychia*, *Letharia*, and other species, on the contrary, are abundant in shaded north-facing pinewoods; there, also the abundance of epiphytic species of *Ochrolechia* and *Cladonia* indicates a subhumid-humid ombroclimate.

31 taxa are new to the Teruel province; among the most interesting species we can cite *Aspicilia mutabilis*, a mediterranean element typical of the Ibero-Levantine supramediterranean areas with subhumid-humid ombroclimate, occurring in *Xanthorion* communities on very sunny and nutrient-rich bark, *Caloplaca stillicidiorum*, which is rare in the high mountains of the Iberian Peninsula *Caloplaca ulcerosa*, located only in old and well-preserved woods, *Catinaria montana* and *Letharia vulpina*, whose records are among southernmost in the Iberian Peninsula, *Thelenella modesta*, which is particularly rare in Central Europe, probably because of recent environmental changes (Mayrhofer, 1987). *Banhegyia setispora* a saprophytic lichenicolous fungus, is especially interesting because of its curious ascospores (Fig. 2), which are hyaline, ellipsoid, with rounded apices, 1-septate, the lower cell somewhat shorter, $20 \times 7.5 \mu$, and setose at both ends; this species is new to Spain.

Acknowledgements

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PHYTOGEOGRAPHICAL ANALYSIS OF THE LICHEN FLORA IN EL TELENO (NW IBERIAN PENINSULA)

Arsenio TERRON ALFONSO

Key words: Phytogeography, Lichens, Iberian Peninsula, Saxicolous, Acidophytic.

Abstract: The saxicolous, acidophytic lichen flora of El Teleno Massif is analysed from the phytogeographical point of view, trying to characterize the different floristic contingents, floristic elements, affinities for the different bioclimatic belts and the different substrata. The synthesis is based on a list of 231 lichen taxa.

Resumen: La flora líquénica saxícola acidófila de el macizo de El Teleno (León, Noroeste de España) es analizada desde el punto de vista fitogeográfico, de forma que se intenta caracterizar los diferentes contingentes florísticos, elementos florísticos, afinidades por los diferentes pisos bioclimáticos y por los diversos substratos rocosos que aparecen en este territorio. Todo ello intenta ser un análisis pormenorizado del comportamiento ecológico mostrado por los 231 taxones que componen la flora líquénica del territorio, y que esto pueda servir para la mejor comprensión del comportamiento de los líquenes en otros territorios continentales.

Introduction

The phytogeographical study of the lichen flora in an area such as El Teleno, situated in the northwest of the Iberian Peninsula, is made difficult by the shortage of knowledge concerning the distribution patterns of many species. Large parts of the Iberian Peninsula are still poorly-known from the lichenological point of view, and the Cantabrian Mountain Range, in which our survey area is included, is not an exception. On the other hand, in the literature there are several examples of "artificial" chorological centers, which clearly coincide with areas where lichenological studies were more intense.

The present analysis is primarily based on the total distribution of the species in Europe, following the concepts by Wirth (1980), Poelt (1969), Poelt & Vezda (1977, 1980), Clauzade & Roux (1985), Nimis & al. (1987) and Nimis & Poelt (1987).

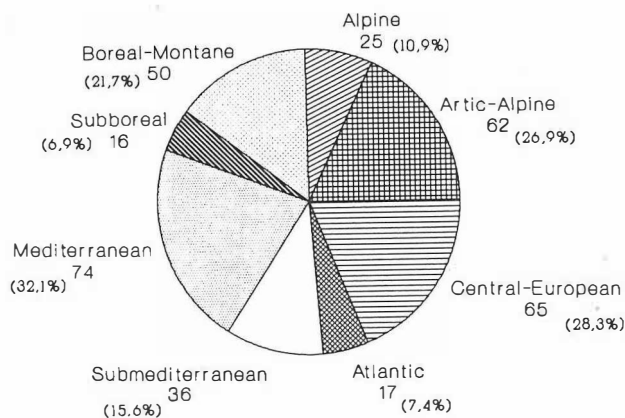
Results

The total number of silicolous species found in the survey area is 231 (Terron, 1991). A first attempt of phytogeographic analysis was based on the main distribution centers of the species, which were subdivided into 8 phytogeographic groups, according to the main vegetation zones of Europe in

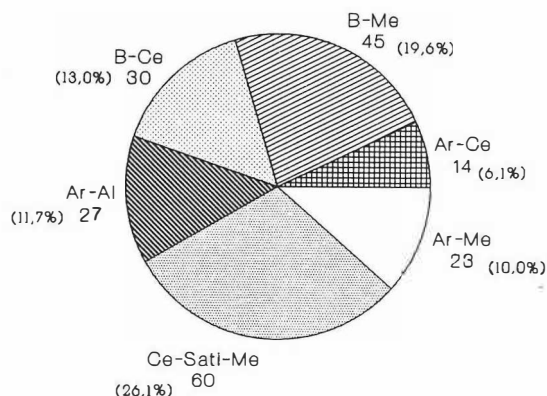
which they are most frequent.

	Nr. sp.	%
Arctic-Alpine (Ar)	62	26.95
Central-European (Ce)	65	28.26
Mediterranean (M)	74	32.11
Boreal-montane (B)	50	21.73
Submediterranean (Sm)	36	15.65
Alpine (Al)	25	10.86
Atlantic (At)	17	7.39
Subboreal (SB)	16	6.95

From these results (Fig. 1a) the importance of the Mediterranean and Central European elements is evident; this is well in accordance with the survey area



a)



b)

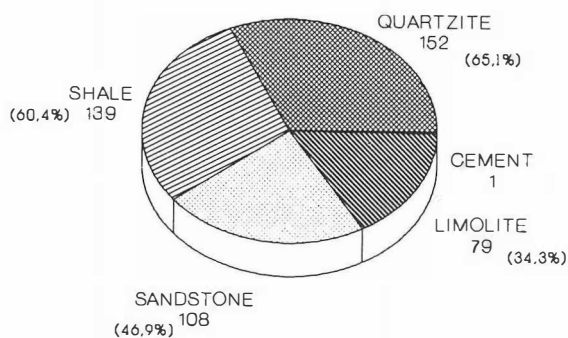
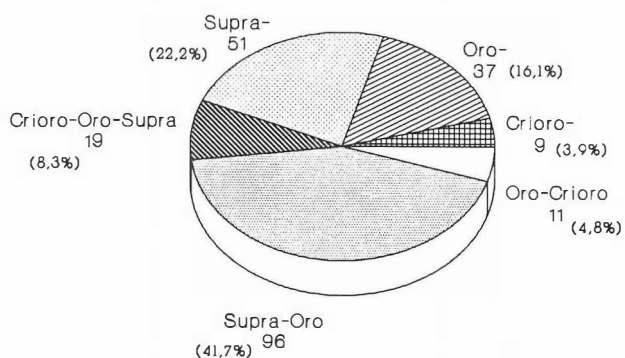
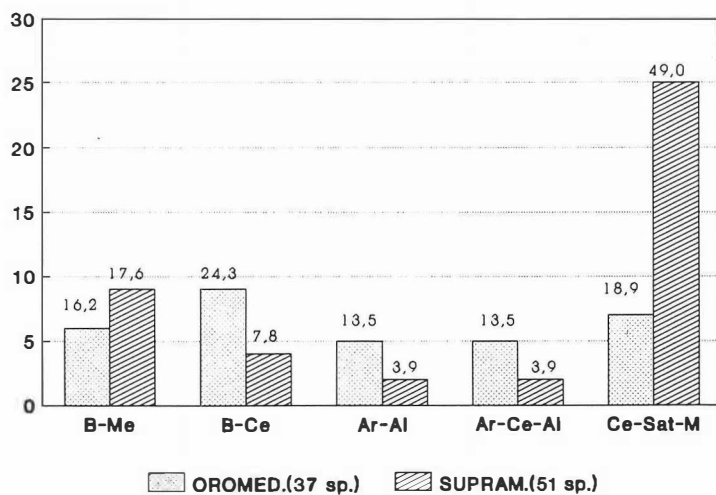


Fig. 1: percent occurrences of Floristic elements (a), floristic contingents (b), number of species for each element (d), in the silicolous lichen flora of El Teleno, percent of contingent/elements in the oro- and supramediterranean belts (c), and number of species found in each substrate-type (e). For further explanations see text.

being situated in the Mediterranean region, following the concepts expressed by Rivas-Martinez (1987). The occurrence of a large number of Arctic and Boreal species is due to the fact that the study was carried out at high altitudes (1200-2185 m). The presence of a small group of Atlantic species indicates a certain influence of humid oceanic air masses, which is particularly pronounced in the southwestern slopes of the massif.

The previous subdivision of the species is only a first, rough attempt of phytogeographic analysis, as many species occur in more than one vegetation zone. Thus, a second attempt to group the species has been carried out on the basis of their occurrence in the main vegetation zones of Europe, following the diagnoses given by Wirth (1980). The results are as follows:

	Nr. sp.	%
Central European.subatl-Mediterr.	60	26.09
Boreal-Mediterranean	45	19.56
Boreal-C. European	30	13.04
Arctic-Alpine	27	11.73
Arctic-Mediterranean	23	10.00
Arctic-C. European	14	6.10

In this second subdivision (Fig. 1b) it is evident that the species reaching the Central European and Mediterranean zones are the majority. The Arctic-Alpine element is poorly represented, which indicates that in southern Europe this element needs higher altitudes than those found in the survey area.

It is possible to subdivide further our data set, on the basis of the occurrence of the different phytogeographic elements in two main altitudinal belts, the supramediterranean and the oromediterranean (Rivas-Martinez 1987). The results are as follows:

	Oromed. (37 sp.)		Supramed. (51 sp.)	
	<u>sp.</u>	<u>%</u>	<u>sp.</u>	<u>%</u>
Boreal-Mediterranean	6	16.21	9	17.64
Boreal-C. European	9	24.32	4	7.84
Arctic-Alpine	5	13.51	2	3.92
Arctic-C. European-Alpine	5	13.51	2	3.92
C. European.subatl.-Mediterranean	7	18.92	25	49.01

From these data (Fig. 1c) it is evident that the Arctic-alpine and the Boreal-montane elements are predominant in the oromediterranean belt, while in the supramediterranean belt the Central European subatlantic-Mediterranean element is most frequent.

Finally, we have subdivided the silicolous lichen flora of the survey area on the basis of the occurrence of the species in different bioclimatic belts (Fig. 1d). Only 9 taxa are exclusive of the criomediterranean belt, which indicates that this belt is not well-developed in the survey area. The oromediterranean belt, on the contrary, is well-characterized by the presence of 37 exclusive taxa. Finally, the supramediterranean belt has 51 exclusive taxa. 19 taxa occur in the supra- oro- and criomediterranean belts, while 96 taxa occur both in the supra- and in the oromediterranean belts.

Finally, the species have been grouped according to their presence on different siliceous substrate-types (Fig. 1e). Noteworthy is the high number of taxa (79) which colonize limolite, which is a rather infrequent substratum in the survey area; they represent 43.35 % of the silicolous lichen flora.

Conclusions

Our results indicate that the phytogeographic characterization of the silicolous lichen flora of the El Teleno is in agreement with the macroclimatic conditions, and especially with the regional bioclimatic features. Several Arctic-alpine and Boreal-montane species are restricted to higher altitudes, where they can survive under a Mediterranean climate. The great bulk of the species belong to the Mediterranean and Central European elements. The small group of Atlantic species indicates a weak Atlantic influence, especially on the southeastern slopes. A criomediterranean belt is evident, although not very pronounced, the most characteristic species being mostly limited to high-altitude areas with strong winds or heavy snowfalls. This agrees with the bioclimatic characterization given by Rivas-Martinez (1987), based on the vascular flora.

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LICHEN SUBSTANCES CONTENT OF SOME SPECIES OF *PARMELIA* ACH. (LICHENES) FROM EASTERN SPAIN

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Eva BARRENO & Victor J. RICO

Keywords: Lichens, Spain, Castelló, València, Chemotypes, TLC, *Parmelia*, Chemistry.

Abstract: 148 specimens of 20 species of *Parmelia* Ach. (lichens) from eastern Spain have been analyzed by TLC, in order to investigate chemical content and to identify chemotypes. This technique allowed us to confirm the occurrence of *P. protomatrae*, *P. delisei*, *P. loxodes* and *P. lusitana* in the territory, these species having often been confused with other related taxa. Interesting results are the occurrence of protocetraric acid in *P. soredians*, the identification of two chemically different groups in *P. pulla* and the presence of the chemotype lacking usnic and physodalic acids in *P. perlata*.

Introduction

The lichen genus *Parmelia* is one of the most well-known and conspicuous among lichenized fungi. In the taxonomy of this group, chemical characters are important, and the genus is certainly one of the better investigated from a chemical point of view. However, in the Iberian Peninsula, only a few extensive studies on the chemistry of *Parmelia* were carried out until now (Rico 1989, Serriña 1990, Rico & al. 1992). As pointed out by Leuckert & Poelt (1978), southern Europe is an interesting area for chemical investigations, as it hosts a considerable number of chemotypes of several species. For these reasons, we planned a chemical study of some species of *Parmelia* collected in a well-delimited, typically Mediterranean area. The main aim of the present work was to identify the lichen substances occurring in all species of *Parmelia* found in this territory and, for chemically variable species, to assign the specimens to a given chemotype.

Survey area

Sampling was carried out in the Serra d'Espadà and Serra Calderona, two areas with high diversity and abundance of species of *Parmelia*. This area (Fig. 1) includes the most extensive siliceous outcrops of eastern Spain, mainly quartz sandstones and argillites. The ecological peculiarity of these territories is determined not only by the parent materials but also by its closeness to the coast and by the incidence of north eastern, humid winds, determining a rather humid climate in some valleys, contrasting with the dryness of the south-facing hillsides. From a bioclimatic point

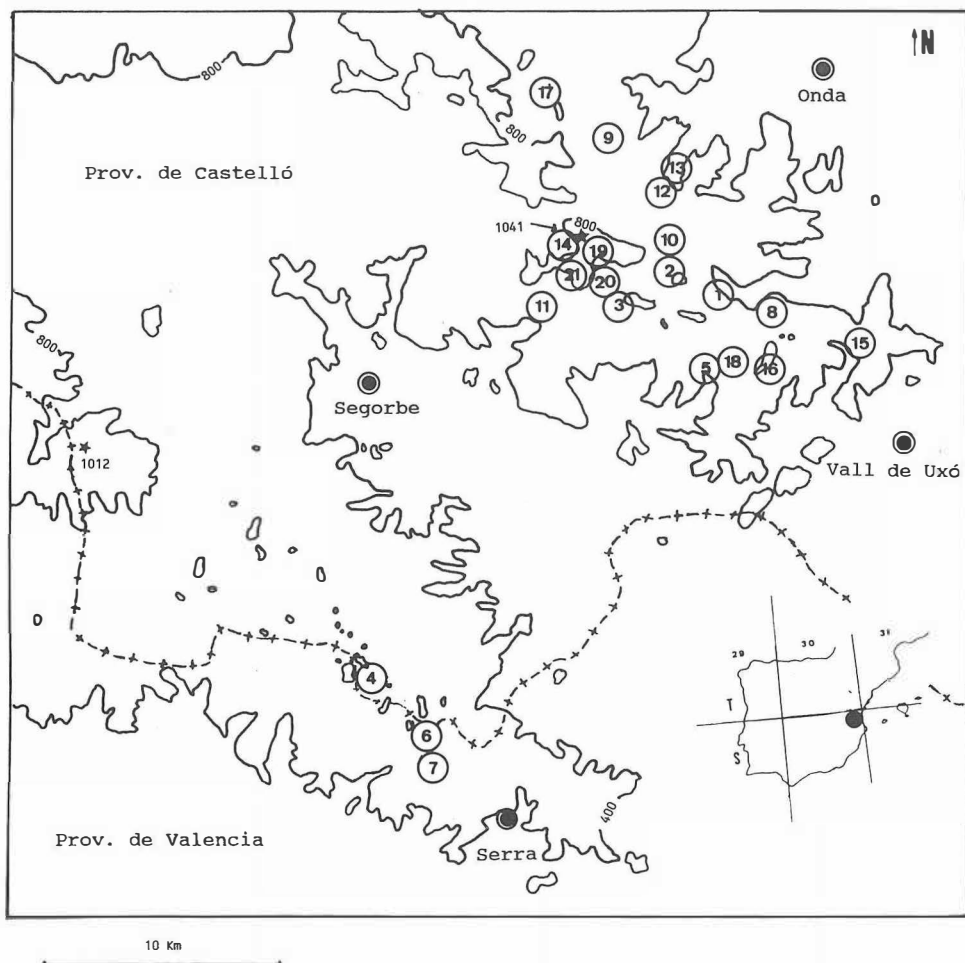


Fig. 1: Survey area with the distribution of the localities sampled.

of view, Espadà mountains are mostly included in the mesomediterranean belt, with subhumid ombroclimate, while Calderona mountains are principally distributed within the termomediterranean belt, with dry to subhumid ombroclimate (Rivas-Martínez, 1987). The most representative vegetation in the area is the cork-oak forest (*Asplenio onopteridis-Quercetum suberis*), disturbed areas being covered by a garrigue of *Cistus monspeliensis* and *Cistus salvifolius*, with a tree layer of *Pinus pinaster* (Costa, 1985).

In the following, we give the list of the investigated localities.

CASTELLO:

1. Eslida, camino l'Oret, 30SYK2918, 450 m
2. Ahín, los Noguerales, 30SYK2718, 725 m
3. Azuebar, Mosquera, 30SYK2517, 640 m
4. Gátova, Gorgo, 30SYK1302, 750 m
5. Chovar, Bco. del Carbón, 30SYK2915, 420 m
8. Eslida, Majadica, 30SYK3016, 650 m
9. Sueras, Bco. de Castro, 30SYK2424, 450 m
10. Ahín, Pico Batalla, 30SYK2719, 860 m
11. Almedíjar, 30SYK2217, 500 m
12. Alcudia de Veo, Alto de Pedralba, 30SYK2523, 600 m
13. Alcudia de Veo, Embalse de Benitandús, 30SYK2724, 450 m
14. Algimia de Almonacid, Bco. Agua Negra, 30SYK2320, 800 m
15. Alfondiguilla, Pico Femella, 30SYK3415, 500 m
16. Alfondiguilla, Pico Nevera, 30SYK3115, 800 m
17. Villamalur, Cerro Moro, 30SYK 2226, 640 m
18. Chovar, Pico Terraguán, 30SYK3016, 620 m
19. Almonacid, near Pico de Espadán, 30SYK2420, 920 m
20. Ahín, Ctra. Ahín-Almedíjar, 30SYK2518, 700 m
21. Ahín, La Ibola, 30SYK2419, 800 m

VALENCIA:

6. Serra, Bco. del Saragutillo, 30SYJ1799, 550 m
7. Serra, Font del Berro, 30SYJ1699, 550 m

Material and methods

148 samples of 20 species of *Parmelia*, 72 occurring on bark and 76 on rock, were analyzed. The analysis and identification of the lichen substances were carried out by thin layer chromatography (TLC). For the solvent systems and conditions we followed Culberson (1972, 1974), Culberson & Kristinson (1970), Culberson & al. (1981), Esslinger (1977) and White & James (1985).

Selected samples of the species studied are included in the following list of species:

Parmelia acetabulum (Necker) Duby - CASTELLO: Gátova, Gorgo, 30SYK1302, 750 m, on *Quercus suber*, 4.II.1984, V. Atienza, VAB-LICH. 0350.

Parmelia caperata (L.) Ach. - CASTELLO: Gátova, Gorgo, 30SYK1302, 750 m, on *Quercus suber*, 4.II.1984, V. Atienza, VAB-LICH. 0592.

Parmelia delisei (Duby) Nyl.- CASTELLO: Villamalur, Cerro Moro, 30SYK2226, 640 m, slates, 14.IX.1991, V. Calatayud, VAB-LICH. 2406/1.

Parmelia fuliginosa (Fr. ex Duby) Nyl. - CASTELLO: Ahín, Los Noguerales, 30SYK2718, 725 m, on *Quercus suber*, 22.II.1987, V. Atienza, A. Muñoz & M.J. Sanz, VAB-LICH. 1551.

Parmelia glabra (Schaer.) Nyl. - CASTELLO: Azuebar, Mosquera, 30SYK2517, 625 m, on *Quercus suber*, 12.IV.1987, A. Muñoz, VAB-LICH. 0591.

Parmelia incolorata (Parr.) Lettau - CASTELLO: Eslida, Cº L'Oret, 30SYK2918, 450 m, on *Quercus suber*, 9.X.1986, A. Muñoz, VAB-LICH. 1572.

Parmelia loxodes Nyl. - CASTELLO: Villamalur, Cerro Moro, 30SYK2226, 640 m, slates, 14.IX.1991, V. Calatayud, VAB-LICH. 2412.

Parmelia lusitana Nyl. - CASTELLO: Alfondiguilla, Pico Femella, 30SYK3415, argillite, 500 m,

20.I.1990, V. Calatayud, VAB-LICH. 1611.

Parmelia perlata (Huds.) Ach. - CASTELLO: Ahín, Mosquera, 30SYK2518, 675 m, on *Quercus suber*, 28.IX.1986, A. Muñoz, VAB-LICH. 0403.

Parmelia protomatrae Gyelnik - CASTELLO: Azuebar, Mosquera, 30SYK2519, quartz sandstone, 660 m, 26.X.1990, V. Calatayud, VAB-LICH. 1820.

Parmelia pulla Ach. - CASTELLO: Azuebar, Mosquera, 30SYK2519, quartz sandstone, 660 m, 15.IV.1989, V. Calatayud, VAB-LICH. 1907.

Parmelia quercina (Willd.) Vainio - CASTELLO: Ahín, Los Noguerales, 30SYK2718, 725 m, on *Quercus suber*, 28.IX.1986, A. Muñoz, VAB-LICH. 0348.

Parmelia somloensis Gyelnik - CASTELLO: Azuebar, Mosquera, 30SYK2517, 625 m, on *Quercus suber*, 26.X.1990, S. Fos, VAB-LICH. 2172.; CASTELLO: Chovar, Bco. del Carbón: 30SYK2915, quartz sandstone, 620 m, 29.IX.1989, V. Calatayud, VAB-LICH. 1744.

Parmelia soledians Nyl. - CASTELLO: Gátova, Gorgo, 30SYK1302, 750 m, on *Quercus suber*, 4.II.1984, V. Atienza, VAB-LICH. 0373. Chovar, 30SYK2915, 450 m, on *Quercus suber*, 21.II.1988, A. Muñoz, VAB-LICH. 0636.; CASTELLO: Alfondeguilla, Pico Femella, 30SYK3415, argillite, 500 m, 20.I.1990, V. Calatayud, VAB-LICH. 1757.

Parmelia subaurifera Nyl. - VALENCIA: Serra, Bco. Saraguttillo, YJ1799, 550 m, on *Quercus ilex*, 12.II.1987, V. Atienza, VAB-LICH. 1550. CASTELLO: Gátova, Gorgo, 30SYK1302, 750 m, on *Quercus suber*, 4.II.1984, V. Atienza, VAB-LICH. 0399.

Parmelia subrudecta Nyl. - CASTELLO: Algimia de Almonacid, Bco. de Agua Negra, 30SYK2320, 800 m, on *Quercus suber*, 17.VI.1989, E. Barreno & A. Muñoz, VAB-LICH. 1556.

Parmelia sulcata Taylor - VALENCIA: Serra, Bco. Saraguttillo, YJ1799, 550 m, on *Pinus halepensis*, 20.I.1986, V. Atienza, VAB-LICH. 1561. CASTELLO: Ahín, Mosquera, 30SYK2518, 675 m, on *Quercus suber*, 22.II.1987, V. Atienza, A. Muñoz & M.J. Sanz, VAB-LICH. 0607.

Parmelia tiliacea (Hoffm.) Ach. - VALENCIA: Serra, Bco. Saraguttillo, YJ1799, 550 m, on *Quercus suber*, 8.X.1986 F. Cuesta, VAB-LICH. 1564. CASTELLO: Sueras, Bco. de Castro, 30SYK2424, 450 m, on *Quercus suber*, 28.IV.1988, A. Muñoz, VAB-LICH. 0657.

Parmelia tinctina Maheu & A. Gillet - CASTELLO: Azuebar, Mosquera, 30SYK2517, quartz sandstone, 620 m, 15.IV.1989, V. Calatayud, E. Barreno, J.M. Sanz & A. Fos, VAB-LICH. 1639.

Parmelia verruculifera Nyl. - CASTELLO: Almedijar, 30SYK2217, 500 m, quartz sandstone, 14.IX.1991, V. Calatayud, VAB-LICH. 2407.

Results

The results of the analyses are summarized in Tab.1.

Conclusions

Our specimen of *Parmelia acetabulum* lacks salazinic acid and atranorin, as in other Mediterranean samples analyzed by Manrique & Crespo (1983).

Some specimens of *Parmelia caperata* can accumulate also atranorin. In the specimens where the method for identifying fatty acid was used, the presence of caperatic acid was observed.

Some specimens of *Parmelia fuliginosa* with partially developed isidia could be confused with *P. subaurifera*. However, in *P. fuliginosa*, rhodophycin occur in the medulla (it can disappear in dead areas of the thallus!) and also the n.i.s. TE-12 is

Tab. 1: Lichen substances identified in the species of *Parmelia*. Abbreviations: AT-atranorin, NR-norstictic acid, CO-connorstictic acid, US-usnic acid, PR-protocetraric acid, FM-fumarprotocetraric acid, LE-lecanoric acid, GY-gyroforic acid, RD-rhodophyscin, ST-stictic acid, CS-cryptostictic acid, CN-constictic acid, HS-hypostictic, SA-salazinic acid, CL-consalazinic acid, ES-stenosporic acid, DI-divaricatic acid, GL-glomellic acid, GO-glomelliferic acid, LU-lusitana unknown?, T12- not identified T12, N.I.S.-not identified sustance; EPI-number of epiphytic samples analyzed; SAX- number of saxicolous samples.

	AT	NR	CO	US	PR	FM	LE	GY	RD	ST	CS	CN	HS	SA	CL	ES	DI	GL	GO	LU	T12	NIS	EPI	SAX	
<i>P. acetabulum</i>		+	+																				1		
<i>P. caperata</i>	±			+	+																		10	7	
<i>P. delisei</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	+	+			*	*		1
<i>P. fuliginosa</i>	*	*	*	*	*		+	+	+	*	*	*	*	*	*	*	*	*	*		+		5	*	
<i>P. glabra</i>	*	*	*	*	*		+			*	*	*	*	*	*	*	*	*	*			*	1	*	
<i>P. incolorata</i>	*	*	*	*	*			±	*	*	*	*	*	*	*	*	*	*	*			*	1	*	
<i>P. loxodes</i>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	+	+			*	*	1	
<i>P. lusitana</i>	*	*	*	+	*	*	*	*	*	+	+	+	+	*	*	*	*	*	*		+		*	5	
<i>P. perlata</i>	+	+	*	*	*	*	*	*	*	+	+	+	+	*	*	*	*	*	*			*	12	4	
<i>P. protomatrae</i>	*	*	*	+	+	+	*	*	*	*	*	*	*	*	*	*	*	*	*			*	1	12	
<i>P. pulla</i>	*	*	*	*	*	*		±	*	*	*	*	*	*	*	*	*	*	*			*	*	14	
<i>P. quercina</i>	+	*	*	*	*	*	+	*	*	*	*	*	*	*	*	+	+	*	*			*	3	*	
<i>P. somloensis</i>	*	+	*	+	*	*	*	*	*	*	*	*	*	+	+	*	*	*	*			*	1	5	
<i>P. soledians</i>	*	*	*	+	±	*	*	*	*	*	*	*	*	+	±	*	*	*	*			*	8	2	
<i>P. subaurifera</i>	*	*	*	*	*	*	+	*	*	*	*	*	*	*	*	*	*	*	*			*	9	*	
<i>P. subrudecta</i>	±	*	*	*	*	*	+	+	*	*	*	*	*	*	*	*	*	*	*			*	12	7	
<i>P. sulcata</i>	±	*	*	*	*	*	*	*	*	*	*	*	*	+	*	*	*	*	*			*	8	5	
<i>P. tiliacea</i>	+	*	*	*	*	*	+	*	*	*	*	*	*	*	*	*	*	*	*			*	*	6	
<i>P. tinctoria</i>	±	+	*	+	*	*	*	*	*	*	*	*	*	+	+	*	*	*	*			*	*	4	
<i>P. verruculifera</i>	*	+	*	*	*	*	*	*	*	*	*	*	*	*	*	+	+	*	*	*	*	+	*	3	

present. According to Esslinger (1977), these substances lack in *P. subaurifera*, but Rico (1989) found one specimen of *P. subaurifera* from central Spain with rhodophyscin.

According to Rico (1989), in *Parmelia glabra* there is a good correlation between the relative concentrations of lecanoric and gyroforic acids and the substrata where the samples grow (epiphytes or saxicolous). In our samples, as in Esslinger (1977), only lecanoric acid occurs, with no traces of gyroforic acid. However, we cannot give a conclusive opinion on this matter, since only a few specimens have been analyzed.

In *Parmelia soledians*, protocetraric acid occurs as accessory substance. According to Culbertson (1969, 1970) and Hale (1976b) this substance seems to be very infrequent in *P. soledians*, but its occurrence has been also reported from other Mediterranean samples (Seriñá, 1990), and from specimens of eastern Africa (Swinscow & Krog, 1988).

Chemical characters are very useful to separate *Parmelia protomatrae* from *P. somloensis*, since some specimens of both species can sometimes be confused. Our samples not only accumulate fumarprotocetraric acid (Hale, 1990), but also protocetraric acid, like in other samples from the Iberian Peninsula (Rico & al., 1992).

Parmelia lusitana, in comparison to the closely related species *Parmelia conspersa*, accumulates an unidentified orange-coloured substance after its development with sulfuric acid (lusitana unknown, Krog 1987), with a R_f in the three solvent systems (A, B y C) which is intermediate between those of stictic and norstictic acids, and norstictic acid is not present. This species is not rare in the territory, and probably it has been often reported from the Iberian Peninsula under *P. conspersa*.

Although Clauzade & Roux (1985) consider *Parmelia tinctoria* as a subspecies of *P. conspersa*, in our opinion stable differences in morphology, chemistry and chorology support the status of species for this taxon, as suggested by other authors (Hale, 1964; Poelt & Vezda, 1981; Rico & al., 1992; Hale, 1990).

According to Hale (1976a), some authors have used the presence of rhizines in the apothecial margins to segregate *P. carporrhizans* Tayl. from *Parmelia quercina*. In the survey area, both taxa have been observed, but no chemical differences have been noted to support the segregation into two species. We prefer to consider *P. carporrhizans* as a morphotype of *Parmelia quercina*.

In our samples of *Parmelia verruculifera*, stenosporic acid occurs as main substance and divaricatic acid is also present, but in lower amounts. Moreover, other two n.i.s. are present.

Two chemical groups are separated in *Parmelia pulla*. In some samples divaricatic acid occurs as main substance, stenosporic acid being less abundant. However, in another group of samples the main substance is stenosporic acid. In one specimen, gyrophoric acid is also present as an accessory substance.

The lichen substances content is a good character for separating *Parmelia delisei* from *Parmelia pulla*. Although both species were often considered as species pairs (sensu Poelt 1972), it seems more natural to relate *Parmelia delisei* with *Parmelia loxodes* (Rico, 1989). In this sense *Parmelia delisei* should be considered as the primary species of *Parmelia loxodes*.

The examined samples of *Parmelia perlata* belong to the chemical race without usnic acid nor physodalic acid (Coassini-Lokar & al., 1987).

Parmelia sulcata, *Parmelia tiliacea* and *Parmelia somloensis* seem to be chemically very homogeneous.

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DISTRIBUTION OF PLANT COMMUNITIES IN THE BADLANDS OF THE UPPER LLOBREGAT BASIN (SOUTHEASTERN PYRENEES)

Roser GUARDIA & Josep M. NINOT

Keywords: Badlands, Erosion, Submediterranean vegetation, Vegetation dynamics.

Abstract: The plant communities of the badlands of a pre-Pyrenean area were studied by means of a geomorphological selection of the eroded areas and 71 phytocoenological relevés with topographic data. The relevés were subdivided into two groups, according to the two kinds of substratum (Eocene marls and Upper Cretaceous clays), and then submitted to Correspondence Analysis. According to these analyses and to abiotic parameters, nine vegetation types can be distinguished. Each community is characterized by ecological groups of species and by different life-forms spectra. The comparison among such communities, as well as with those of the non-eroded areas, allows to discuss their dynamic relationships in relation with erosion processes. As a general rule, erosive dynamics involves a regressive succession from the previous community (normally a meso-xerophilous pasture) through the opening of gaps and the loss of mainly mesophilous species. Thus, the badland communities on each substratum are dynamically connected, most stands having medium- to very low coverages and diversity, the topographic position and the related erosive processes being the most influential factors on their distribution.

Introduction

In the Upper Llobregat basin badlands are widespread and, although they occupy only small areas, they are the main fluvial sediment source in the basin (Clotet & al. 1988). Geomorphological studies were carried out in the area mainly concerning erosion rates (Clotet & Gallart 1986), but no attempts were made to study plant communities of these badlands. Vegetation is a regulating factor of erosive processes as it protects the soil against the action of falling raindrops, reduces the speed of the surface runoff, increases the degree of infiltration (Cervera & al. 1991) and binds the soil mechanically (Zachar 1982).

The aim of the present study was to describe the plant communities in the badlands of the Upper Llobregat basin, in order to establish a model on the relationships between plant communities and abiotic parameters. The dynamic connection among plant communities, as well as between such communities and those of the non-eroded slopes, is directly related with the general dynamics of the badlands. This knowledge will be the basis for studying the quantitative dimension of the reduction of erosion by vegetation and, on the other hand, it provides useful information for the attempts of rehabilitation of the badlands or

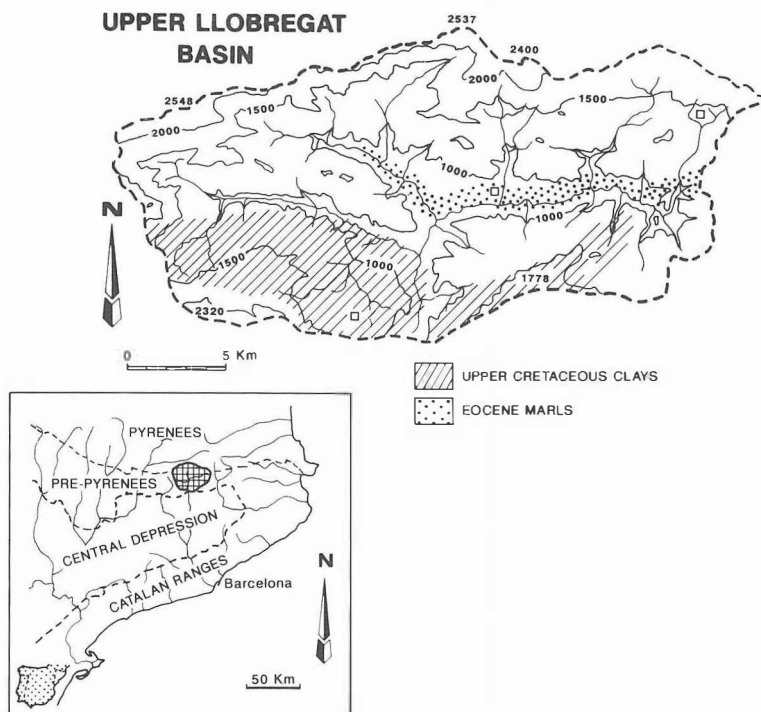


Fig. 1 - Location of the study area.

other bare areas.

Study Area

The study area is located in the Upper Llobregat basin, southeastern Pyrenees, Catalonia (Fig. 1). Most of the geological material is carbonated and is mainly part of the Pedraforca mantle Unit and the Cadí Unit. The elevation of the badlands ranges from 790 to 1320 m; they occur on all exposures, but are most common on north-facing slopes. The eroded patches develop mainly on two substrata: Eocene marls and upper Cretaceous clays.

The badland topography in the Eocene consists of marls interspersed with beds of more resistant rocks, mainly sandstones and calcarenites. Generally, the drainage network is less dense on marl than on clay, this fact being mainly related to lithologic characteristics. A main channel usually develops in the soft marls, the lateral outcrops of hardrock beds preventing branching of the drainage network. Thus, the slopes are long and steep with wide thalwegs holding deposits of debris, chiefly in their basal part (Fig. 2).



Fig. 2 - General view of badlands in Eocene marls.

The Cretaceous formation mainly consists of lacustrine clays. Badland topography is here more densely and deeply dissected than in Eocene marls. The slopes are short and steep and the thalwegs are quite narrow.

The climate is submediterranean-like with some continental features (Martín Vide & al. 1989). The annual average rainfall is 850 mm at lower altitudes and about 1100 mm at upper elevations, with two dry periods in January-February and July, the latter being very restrictive for plant activity. The average annual temperature is 11.4°C at 1000 m, with 17°C of amplitude among monthly averages.

The landscape of the area consists mainly of *Pinus sylvestris* forests and pastures, both of which ranging from xerophilous types at lower altitudes to meso-higrophilous in the moistest zones (Soriano 1984). Most of the *Pinus sylvestris* forests hold well-developed shrubby and herbaceous layers, with plenty of calcicolous and meso-xerophilous species (formerly *Buxus sempervirens*), and belong to the *Buxo-Quercetum pubescentis*. These submediterranean pine forests develop at almost all exposures and altitudes, with some secondary differences concerning composition, density of the different layers, etc. Only on the upper north-facing slopes there occur some moss-rich *Pinus sylvestris* forests (*Polygalo-Pinetum sylvestris*), adapted to colder

and moister climates and related to the *Pinetalia sylvestris* alpine communities. The more extended pastures are those of the *Aphyllanthion*; these are calcicolous communities resistant to dry summers, especially those of the *Brachypodio-Aphyllanthetum*, inhabiting south-facing areas and chiefly formed by low shrubs and xerophyllous grasses; the *Seslerio-Aphyllanthetum*, with meso-xerophilous to mesophilous plants, occurs on north-facing slopes. Mesophilous pastures (*Euphrasio-Plantaginetum mediae*, *Mesobromion erecti*) develop only on deep soils, normally on flat or gentle spots. Intermediate communities between pasture and forest are very frequent, consisting of an open layer of *Pinus sylvestris* and any of the mentioned pastures as herbaceous layer.

Methods

After the localization of the badlands with aerial photographs, some of them were selected to give a representative sample based on obvious environmental differences: substratum, exposure, altitude, size of the badland area and vegetation of the neighbouring slopes. Several plots were subjectively chosen in each badland zone according to their landform components: upper part of slope, backslope, footslope and main channel (thalweg; see figure 9).

The vegetation samples taken in each plot consist of phytocoenological inventories or relevés (Braun-Blanquet 1979). Nomenclature follows Flora Europaea (Tutin 1964-1980). Topographic data were also recorded, concerning elevation, exposure, slope angle and position in the slope. Moreover, some representative relevés of the neighbouring non-eroded areas were taken in order to allow a comparison between the communities of the normal sites and those of the badlands.

The 71 relevés were distributed into two tables according to the substratum (upper Cretaceous clays or Eocene marls), as this factor would have obscured the topographic factors. Each table was submitted to Correspondence Analysis (CA; Benzecri 1973), in order to obtain relevé groups. For each group formed by CA, frequency and average cover of each species were calculated. Some difficulties were encountered in associating the groups of relevés formed through CA with associations or higher phytocoenological syntaxa. However, each group of relevés can be characterized by some groups of species with a particular ecological significance, these species groups being related to phytocoenological alliances or to ecological groups with a broader meaning. The following species groups have been used in the typification of the relevés:

- plants of the submediterranean meso-xerophilous pastures (most of which are related to *Aphyllanthion*),
- plants of the centroeuropean mesophilous pastures (mainly related to *Mesobromion*),
- thermophilous plants (Mediterranean plants limited, in the study area, to

sunny and warm slopes),
- plants of humid and clayish soils.

Moreover, the biological spectra for each relevé group has been obtained, with the following life-forms: graminoid hemicryptophytes, non-graminoid hemicryptophytes, chamaephytes, phanerophytes, therophytes, geophytes.

Results

Eocene marls

Figure 3 shows the results of CA for the relevés of the marls arranged on the first two axes, which account for 23.95 % of the total variance. The points (relevés) tend to form four groups. Table 1 shows the frequency and the cover percentage of the species in each group. The inclination and exposure of each group of relevés are represented in Figure 4. Figure 5 displays the percentage cover of the species classified according to ecological significance and life-form. Specific percentage compositions are based on species cover as a percentage of the total vegetation cover for each community.

The relevé groups represent a sequence from the supposed vegetation preceding the erosive processes (a pasture belonging to the *Aphyllanthion* like those normally occurring above the badland, further up the slope) to the almost bare surfaces of the backslopes (Fig. 9). Thus, in the upper part of the badlands, where the erosive processes are relatively recent, a gradual transition between the pastures neighbouring the badland and the most eroded areas can be observed. These upper parts are the result of degradation of the initial pasture, through the loss of species and the opening of gaps among the remaining plants. Two different communities (groups I and II) can be distinguished in this upper slope position, the former mainly with south-facing exposures and the latter with north-facing aspects. Group III corresponds to backslopes, with a very degraded and poor vegetation. The remaining group (IV) includes the communities developing in the thalwegs.

Globularia vulgaris and *Aphyllanthes monspeliensis* community (I)

This community is closely related to the *Brachypodio-Aphyllanthetum*, with a rather diverse cover, although the average is somewhat high (48%). There chamaephytes clearly prevail (52.3% of the cover), most of them being thermophilous (*Thymus vulgaris*, *Lithodora fruticosa*, *Coris monspeliensis*, etc.). Among the herbaceous component, graminoid plants are the most abundant, mainly *Aphyllanthes monspeliensis* and *Avenula pratensis* subsp. *iberica*.

Satureja montana and *Sesleria coerulea* community (II)

This occurs on the same relative position of the slope as the preceding

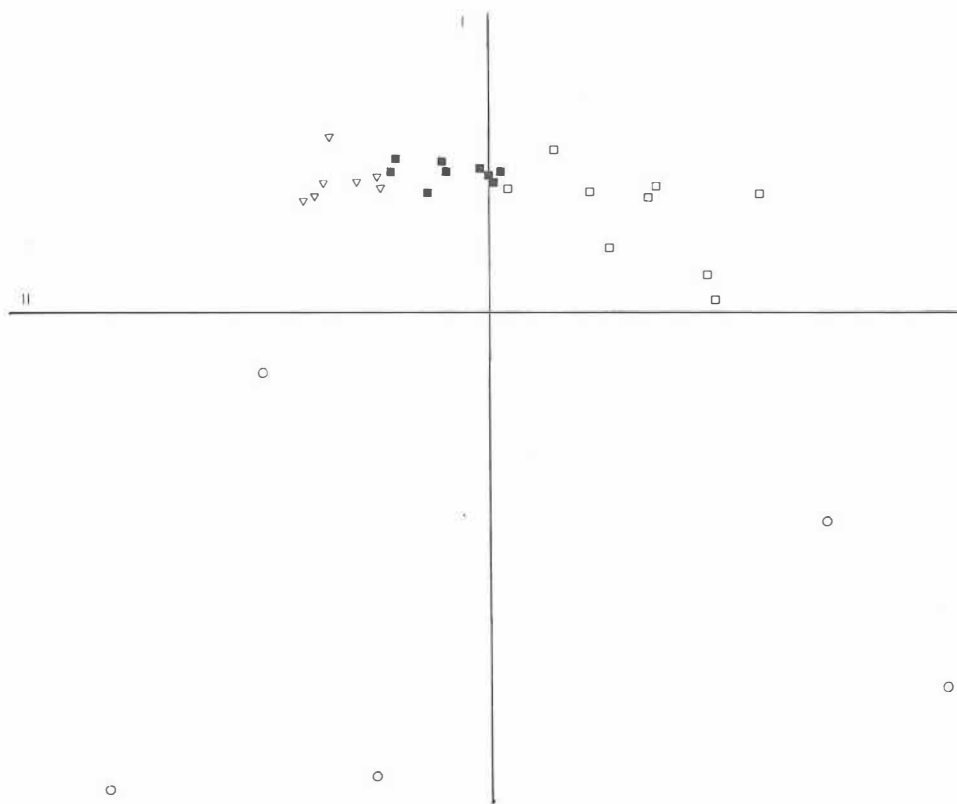


Fig. 3 - Arrangement of relevés from Eocene marls according to the two first axes of CA. Empty square: Group I; triangle: Group II; full square: Group III; circle: Group IV.

community, with similar cover, but the predominant north-facing exposures determine a different plant composition. Grasses are the most important group here, with *Sesleria coerulea* as the main component. There are some species of humid or clay soils (*Molinia coerulea*, *Plantago serpentina*, etc.) but with low covers. The community is a degraded form of the *Seslerio-Aphyllanthesetum*, the most common pasture on the normal north-facing slopes in the area.

Laserpitium gallicum and *Erucastrum nasturtiifolium* community (III)

The most eroded areas in these badlands are the extensive backslopes, occurring mainly on north-facing exposures. The inclination is higher than for the other communities (35-40°). The poorest and most common community develops on such unfavourable place. Its cover is the lowest (26%), as it comes from a short list of plants with low abundances (+ or 1). The biological spectrum shows a similar cover for woody species (phanerophytes and chamaephytes,

Table 1 - Synthesis of the Eocene marls relevés, with the species arranged according to ecological groups. In each column the frequency (% of occurrence) and the average cover in the community (CR, coverage rate, in %) for each species is shown.

GROUPS	I		II		III		IV	
Summarized relevés	9		7		9		5	
	%	CR	%	CR	%	CR	%	CR

Plants of the submediterranean pastures

<i>Anthyllis montana</i>	33	0.03	71	3.25	12	0.01	14	0.01
<i>Aphyllantes monspeliensis</i>	88	4.74	14	0.01	12	0.01	14	0.01
<i>Argyrolobium zanonii</i>	55	0.6	14	0.01				
<i>Asperula cynanchica</i>	22	0.02	71	0.77	62	0.06	71	0.07
<i>Astragalus monspessulanum</i>	44	0.04	14	0.01				
<i>Avenula iberica</i>	77	6.42	42	0.04	62	0.67	42	3.92
<i>Carduncelus monspeliacus</i>	11	0.01	42	0.04			14	0.01
<i>Carex humilis</i>	44	1.13	28	0.02	12	0.01	14	0.01
<i>Catananche caerulea</i>							28	2.51
<i>Coronilla minima</i>	44	0.04	57	2.54			14	0.01
<i>Euphorbia mariolensis</i>	88	0.63	28	0.02	50	0.66	71	0.07
<i>Globularia cordifolia</i>	55	0.6	42	1.44	12	0.01	14	0.01
<i>Globularia vulgaris</i>	77	5.27	14	0.01	12	0.01		
<i>Helianthemum italicum</i>	44	1.13						
<i>Koeleria vallesiana</i>	77	5.03	57	0.75	25	0.63	28	0.02
<i>Lavandula latifolia</i>	100	4.75	28	0.72	37	2.82	42	3.22
<i>Lavandula pyrenaica</i>	11	0.01	71	1.47	25	0.02	14	0.01
<i>Linum salsoloides</i>	88	3.11	100	0.8	87	1.31	57	0.75
<i>Santolina chamaecyparissus</i>	77	1.71	28	0.02	62	0.06	57	0.75
<i>Teucrium aureum</i>	100	2.27	85	4.67	75	1.3	57	0.05
<i>Thesium divaricatum</i>	11	0.01			12	0.01		

Plants of the centroeuropean mesophilous pastures

<i>Bromus erectus</i>	22	0.56					14	0.71
<i>Euphrasia salisburgensis</i>			28	0.02			14	0.01
<i>Koeleria pyramidata</i>	33	0.57	71	0.07	25	0.63	42	0.74
<i>Onobrychis supina</i>	33	0.57	85	1.48	12	0.01	57	1.45
<i>Sesleria coerulea</i>	33	2.51	85	21.0	50	3.45	42	7.87

Termophilous plants

<i>Coris monspeliensis</i>	66	0.06						
<i>Dorycnium pentaphyllum</i>	66	2.54	14	0.01			28	0.02
<i>Fumana ericoides</i>	33	1.12			12	0.01	14	0.71
<i>Lithodora fruticosa</i>	22	0.56						
<i>Thymus vulgaris</i>	88	4.2	42	0.04	25	0.63	28	1.42

Plants of humid and clayish soils

Carex flacca					57	0.75
Chlora perfoliata					28	0.72
Jasonia tuberosa	11	0.01	71	3.95	42	0.04
Molinia caerulea			71	0.07	42	20.3
Plantago serpentina	22	0.02	71	1.47	25	0.02
Tussilago farfara					25	0.02
					14	0.01

Others

Achnatherum calamagrostis	22	0.02	71	5.04	37	5	57	3.94
Amelanchier ovalis	22	0.56	28	0.02	12	0.01	14	0.01
Anthericum liliago			28	0.02			14	0.01
Artemisia alba	55	1.14	14	0.01	12	0.01	42	0.04
Brachypodium phoenicodes	44	1.67					42	13.2
Brachypodium retusum	22	0.56						
Bupleurum rigidus	11	0.55					28	3.21
Buxus sempervirens	11	0.01	14	0.01	25	0.02	14	0.01
Campanula hispanica	22	0.02	71	0.07	12	0.01	42	0.04
Campanula speciosa	11	0.01	57	0.75	37	0.65	28	0.02
Cephalaria leucantha	44	0.58			12	0.62	42	2.52
Cirsium sp			14	0.01			14	0.01
Cirsium vulgare							14	0.01
Clematis vitalba					12	0.01	14	0.01
Convolvulus arvensis	11	0.01	14	0.01	12	0.01		
Crataegus monogyna	11	0.01					28	0.02
Cruciata glabra			42	1.44	50	0.05	42	0.04
Dactylis glomerata							42	3.92
Daucus carota	11	0.01					42	0.74
Echinops sphaerocephalon	11	0.01					14	0.01
Erucastrium nasturtifolium	22	0.02			100	1.32	42	0.04
Euphorbia nicaensis			42	0.04				
Euphorbia serrata	44	0.04			12	0.01	14	0.71
Festuca gautieri			42	0.04			14	0.71
Festuca sp	11	0.55			12	0.01	14	0.01
Fumana procumbens	22	0.02						
Galium lucidum	11	0.01			25	0.02	42	0.74
Galium pumilum	22	0.02			12	0.01	14	0.01
Genista scorpius	100	4.75	28	0.02	37	0.03	85	2.18
Hieracium cerinthoides			42	0.04	25	0.02	28	0.72
Hieracium sp			57	0.75	62	0.67	42	0.74
Knautia catalaunica	22	0.02	85	0.78	37	0.03	42	0.74
Laserpitium gallicum	44	1.13	71	2.55	87	6.88	57	2.85
Leontodon hispidus							28	0.02
Leucanthemum pallens	22	0.02					28	0.02
Linum catharticum							28	0.02

Linum viscosum	11	0.01			12	0.01	14	0.01
Lotus corniculatus							57	0.75
Odontites lutea	11	0.01	14	0.01				
Ononis fruticosa	33	4.73			37	2.21	28	0.72
Phyteuma orbiculare			42	0.04			14	0.01
Picris hieraciodes			14	0.01	12	0.01	14	0.01
Pinus nigra	11	1.94			12	2.18	14	0.01
Pinus sylvestris	55	0.6	71	3.25	75	5.65	57	0.75
Potentilla verna			14	0.01			28	0.02
Prunella grandiflora							28	0.72
Prunus mahaleb	11	0.01	28	0.02	12	0.01	14	0.01
Ptychotis saxifraga	11	0.01	28	0.72	25	0.63	14	0.01
Reseda phyteuma	22	0.02			37	0.03		
Reseda lutea					25	0.02	14	0.01
Rosa agrestis	11	0.01					14	0.01
Sanguisorba minor	33	0.03	71	0.77	100	1.32	100	1.5
Satureja montana	44	1.13	85	2.18	87	2.87	57	0.75
Scabiosa columbaria	22	0.02	14	0.01	12	0.01	14	0.01
Succisa pratensis			14	0.01			14	0.01
Teucrium chamaedrys	55	0.6	28	0.02	37	0.03	28	0.72
Valeriana montana			28	0.02				

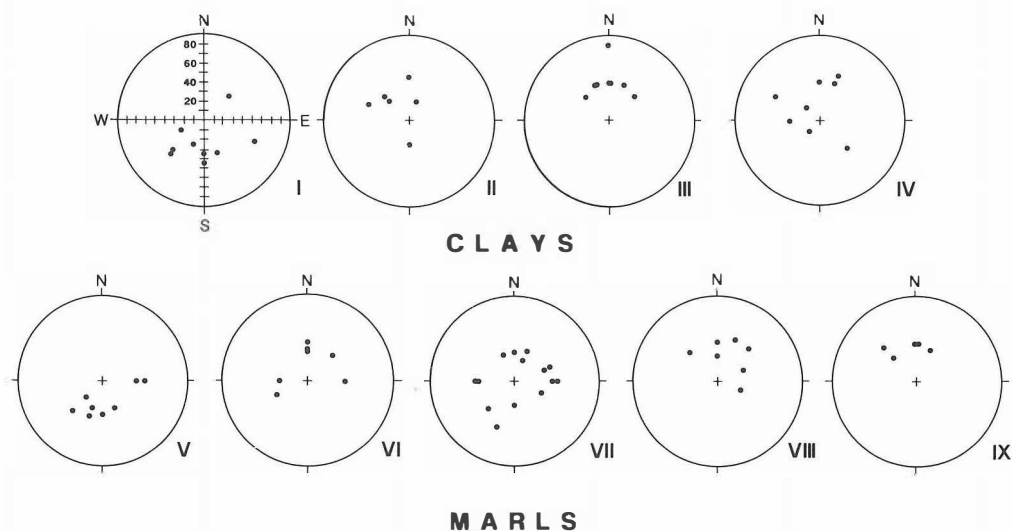


Fig. 4 - Schematic representation of the exposure and slope angle of each group of relevés. Dots represent the stands of the respective groups. The center of each circle represents a position of no slope and exposure, and the periphery of each circle is 100 % slope with exposure indicated.

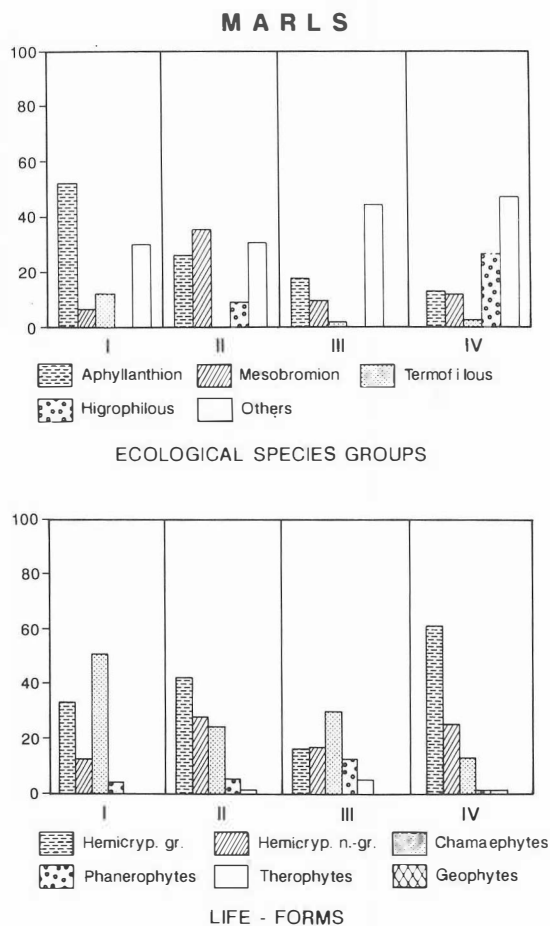


Fig. 5 - Percentage cover of species classified according to their ecological significance and to their life-form in the Eocene marls.

41.4%) and for herbaceous ones. Some of these species are also present in the *Aphyllanthion* pastures, where they, nevertheless, play a secondary role (*Linum salsoloides*, *Koeleria vallesiana*, *Santolina chamaecyparissus*, etc.). The weathering of the bedrock frequently produces a superficial layer of gravel that allows, on the other hand, the occurrence of some plants adapted to screes (*Achnatherum calamagrostis*, *Laserpitium gallicum*, etc.). Thus, this community turns out to be very different from the initial pasture

Thalweg vegetation (IV)

Although the relevés that make up this group do not seem closely related to one another in the CA (Fig. 3), as a whole they are rather distant from the others.

The thalwegs receive much of the runoff and sediment from the hillslopes, and this fact is reflected in the amount and type of herbage produced. This vegetation achieves the maximum cover in the badlands (74% average). The herbaceous layer is relatively dense, and mainly formed by grasses, as the higher water availability in the thalwegs allows the development of some mesic species (*Molinia caerulea*, *Sesleria caerulea*, *Carex flacca*, etc).

The inclination of thalwegs represented in Figure 4 corresponds to their axis, coincident with the maximum inclination of the general slope. However, each plot sampled is a strip including, on both sides of the axis, a range of different inclinations and exposures. Moreover, each sampled plot includes an upper and a lower part of a thalweg which are rather different in meaning of substratum depth, humidity, etc. Thus, the sampling method (based on the homogeneity of the plots) became rather unsuitable for thalweg study. Besides this heterogeneity within each plot, thalwegs seem somewhat diverse as they are not very restrictive sites for species settling, as well as for remaining plants from the original communities.

Upper Cretaceous clays

The relevés from Cretaceous substrata are presented in Table 2, and the result of CA is shown in Figure 6, where the two axes account for 17.23% of the variance. Figure 7 displays the percentage cover of the species classified according to their ecological significance and to their life-form. A similar relevé distribution into groups as in Eocene marls can be observed, and also a similar vegetation dynamics relationship can be modeled, but some differences should be pointed out (fig. 9). The thalweg group (VIII) is not evidenced by CA because it is not a very well-defined community, but this set of relevés was taken as a whole to allow the comparison between the two substratum communities. On this substratum the transition between pasture and badland occurs suddenly, through a well-marked step. Below this step, a medium-covered zone represents a degradation of the original pastures as on the Eocene materials. Two similar communities can also be recognized here, south-facing (V) and north-facing (VI), the latter with lower cover. Backslopes are the harshest environments; they bear a community (VII) comparable to group III in Eocene marls but with lower plant cover. In addition, a new group (IX) restricted to Cretaceous materials, has appeared.

Brachypodium phoenicoides and *Aphyllanthes monspeliensis* community (V).

The relevé plots are mainly on south-facing exposure, and on medium inclinations. The prevalent life-form is the graminoid type (48.9% of the total cover), with *Aphyllanthes monspeliensis*, *Brachypodium retusum* and *B. phoenicoides* as dominant species. The community is close to the meso-xerophilous pastures,

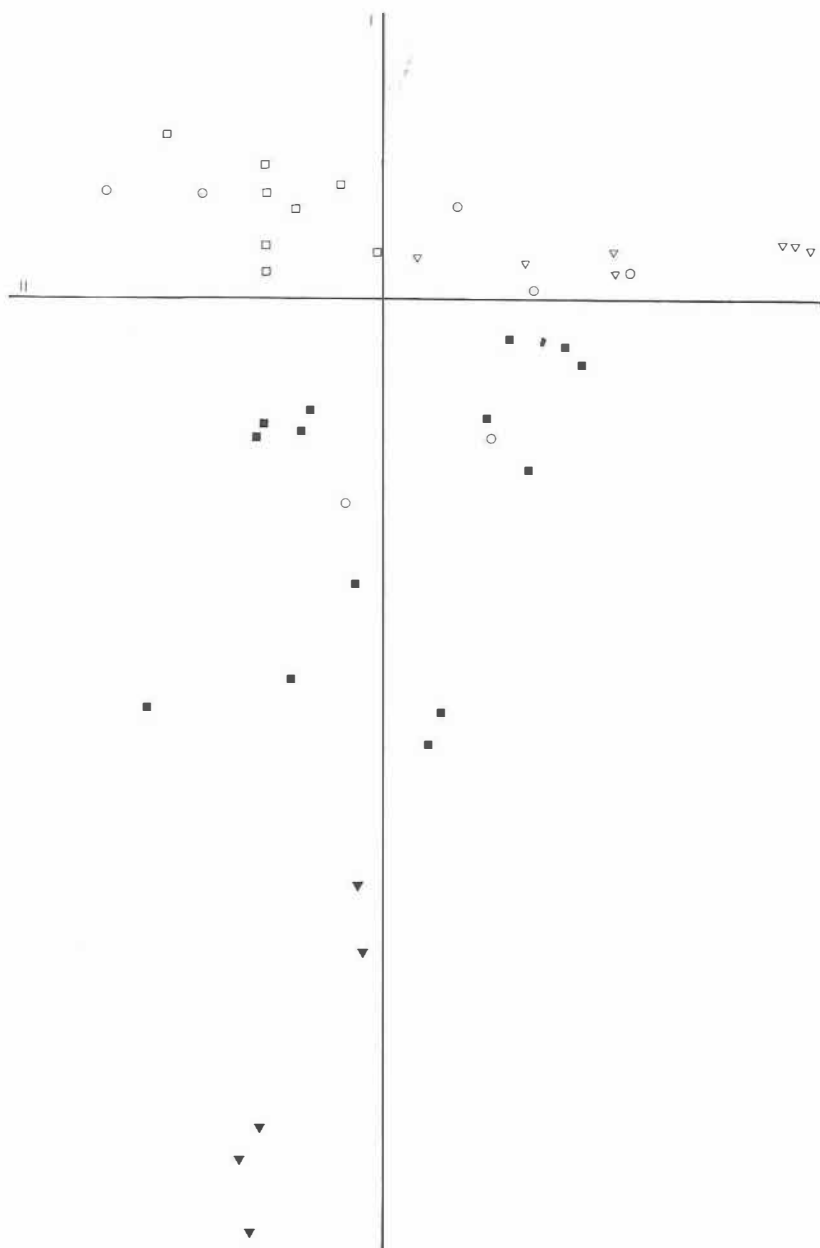


Fig. 6 - Arrangement of clay relevés according to the first two axes of CA. Open square: Group V; open triangle: Group VI; dark square: Group VII; open circle: Group VIII; dark triangle: Group IX.

Table 2 - Synthesis of the Upper Cretaceous relevés, with the species arranged according to ecological groups. In each column the frequency (% of occurrence) and the average cover in the community (CR, coverage rate, in %) for each species is shown.

GROUPS	V		VI		VII		VIII		IX	
Summarized relevés	8		7		14		7		5	
	%	CR	%	CR	%	CR	%	CR	%	CR
Plants of the submediterranean pastures										
<i>Anthyllis montana</i>	25	2.81	57	0.75	7.1	0.00	14	0.01		
<i>Aphyllantes monspeliensis</i>	87	12.2	57	1.45			42	11.4		
<i>Argyrolobium zanonii</i>	25	1.25					14	0.01		
<i>Asperula cynanchica</i>	25	0.63	14	0.01	35	0.03	42	0.04	20	0.02
<i>Astragalus monspessulanum</i>	62	1.9	28	3.21	14	0.01				
<i>Avenula iberica</i>	50	1.88	42	0.74	57	1.3	57	5.72	40	1.02
<i>Carduncelus monspeliacus</i>	75	2.25			21	0.02	14	0.01		
<i>Carex humilis</i>	37	6.56	57	0.75	7	0.00	57	1.45		
<i>Coronilla minima</i>	25	0.02	57	0.05	7	0.00	14	0.01		
<i>Euphorbia mariolensis</i>	50	0.05			14	0.01				
<i>Globularia cordifolia</i>	62	4.07	28	0.02	14	0.01				
<i>Globularia vulgaris</i>	25	0.02			14	0.36			20	0.02
<i>Helianthemum italicum</i>	62	0.67	71	2.17	14	0.01	28	0.72	20	0.02
<i>Hippocrepis comosa</i>			28	1.42	7	0.00				
<i>Koeleria vallesiana</i>	100	2.55	100	0.1	42	0.74	57	0.05	40	0.04
<i>Lavandula pyrenaica</i>	62	4.41	100	1.5	21	0.02	42	0.04	40	0.04
<i>Linum salsoloides</i>	100	1.93	42	0.04	50	0.05	42	0.04	20	0.02
<i>Santolina chamaecyparissus</i>	75	0.68	28	0.02	35	0.38	42	2.52		
<i>Teucrium aureum</i>	50	0.66	71	1.47	42	0.04	14	0.01		
<i>Teucrium pyrenaicum</i>	12	0.01			14	0.01	14	0.01		
<i>Thesium divaricatum</i>	12	0.01	14	0.01						
Plants of the centroeuropean mesophilous pastures										
<i>Bromus erectus</i>	25	0.63					14	0.01		
<i>Carlina vulgaris</i>	25	0.02								
<i>Euphrasia salisburgensis</i>					14	0.01			20	0.02
<i>Koeleria pyramidata</i>					7	0.00	14	0.01	20	0.02
<i>Onobrychis supina</i>	87	1.92	71	0.77	35	0.73	28	2.51		
<i>Sesleria caerulea</i>			100	16.4	28	0.72	28	5	40	0.04
Termophilous plants										
<i>Coris monspeliensis</i>	62	0.06								
<i>Dorycnium hirsutum</i>			28	0.72						
<i>Dorycnium pentaphyllum</i>	75	1.91			14	0.01				

<i>Fumana ericoides</i>	62	0.06	14	0.01	14	0.01	14	0.01
<i>Lithodora fruticosa</i>			14	0.71	14	0.71		
<i>Sideritis hirsuta</i>	12	0.01			21	0.02		
<i>Thymus vulgaris</i>	87	2.53	28	0.02	21	0.02		

Plants of humid and clayish soils

<i>Carex flacca</i>	12	0.01			14	0.01	57	6.8
<i>Chlora perfoliata</i>	37	0.03					14	0.01
<i>Molinia caerulea</i>			28	0.72			28	3.21
<i>Jasonia tuberosa</i>	12	0.01	42	0.04	14	0.01	71	2.55
<i>Plantago serpentina</i>	25	0.63	57	1.45	57	1.10	85	1.48
<i>Tussilago farfara</i>					35	1.08	42	0.74

Others

<i>Achnatherum calamagrostis</i>			42	3.92	7	0.00	57	3.94
<i>Brachypodium phoenicoides</i>	75	7.82	28	0.72	21	0.02	57	12.8
<i>Brachypodium retusum</i>	62	14.0			7	0.00		
<i>Buxus sempervirens</i>			28	0.02			14	0.01
<i>Campanula hispanica</i>	25	0.02						20
<i>Campanula speciosa</i>	37	0.03	42	0.74	50	1.1	14	0.71
<i>Centaurea scabiosa</i>	50	0.05	14	0.01	42	1.63	28	0.02
<i>Cirsium vulgare</i>	62	0.06	14	0.71	7	0.00	28	0.02
<i>Convolvulus arvensis</i>	37	0.65			50	3.58	14	0.01
<i>Dactylis glomerata</i>	37	1.26	28	0.02	14	0.01	42	2.52
<i>Daucus carota</i>							28	0.02
<i>Erucastrum nasturtifolium</i>	12	0.01			21	0.37		
<i>Eryngium campestre</i>	37	0.03			7	0.00	14	0.01
<i>Festuca grovina</i>	50	0.66			14	0.01		20
<i>Festuca sp</i>			14	0.71			14	0.01
<i>Galium pumilum</i>	37	1.26			7	0.00	14	0.01
<i>Genista scorpius</i>	100	15.3	71	4.65	78	0.42	85	0.08
<i>Hieracium cerinthoides</i>			28	0.72	7	0.00	28	0.02
<i>Hieracium piliferum</i>	25	0.02						20
<i>Hieracium pilosella</i>	12	0.01	28	0.02	7	0.00	14	0.01
<i>Hieracium sp</i>			28	2.51	14	0.01		20
<i>Hypochoeris radicata</i>	25	0.02	14	0.01	14	0.01	14	0.71
<i>Juniperus communis</i>	25	0.02	14	0.01				20
<i>Knautia catalaunica</i>	25	0.02	28	0.02	35	0.73	57	0.75
<i>Leontodon hispidus</i>			14	0.01			14	0.01
<i>Leucanthemum vulgare</i>					7	0.00	42	0.04
<i>Linum catharticum</i>			14	0.01			14	0.01
<i>Lotus corniculatus</i>	25	0.02	28	0.72	21	0.02	28	0.02
<i>Ononis natrix</i>	12	0.01					14	0.01
<i>Orchis sp</i>			28	0.72			14	0.01
<i>Pinus sylvestris</i>	37	1.26	100	3.98	50	0.4	85	2.18
<i>Plantago lanceolata</i>					7	0.00	14	0.01

Platanthera sp		14	0.01		14	0.01	20	0.02
Potentilla verna	12	0.01	28	0.02		14	0.01	
Prunella vulgaris	12	0.01			7	0.00	14	0.01
Prunus mahaleb	12	0.01			7	0.00		
Ptychotis saxifraga	25	0.02	14	0.01	14	1.25	28	0.02
Quercus pubescens	12	0.01			7	0.00	14	2.5
Reseda phyteuma					14	0.01		
Rosa sp	12	0.01					14	0.01
Sanguisorba minor	25	0.02	42	0.04	71	0.07	85	0.08
Taraxacum officinale	12	0.01			7	0.00	14	0.01
Tetragonolobus maritimus							28	0.02
Teucrium chamaedrys	25	2.2			7	0.00		
Thymelaea nivalis			42	1.44			14	0.01
Trifolium pratense					7	0.00	14	0.01

as indicated by the high percentage of *Aphyllanthion* taxa (45.8% cover). This community is quite related to group I of Eocene marls, also holding thermophilous plants, but here grasses are more abundant than chamaephytes.

Helianthemum oelandicum and *Sesleria coerulea* community (VI)

The main differences from the preceding community lie in the fact that this community develops on moister soils, hosting species of the mesic pastures of *Aphyllanthion* (*Seslerio-Aphyllanthetum*). Grasses are dominant (45.1%), but here *Sesleria coerulea* clearly dominates, in the form of detached turfs among the bare parts of the slope (Fig. 8).

Plantago serpentina and *Campanula speciosa* community (VII)

Plant cover is lower here than elsewhere. Moreover, there are frequently plants with low vitality, over-developed root systems (often partially uncovered), abnormally reptant forms, some mechanical damages, etc. They belong to the so-called stress-tolerant group (Grime 1979). They are long-lived plants with a range of features which basically represent adaptations for endurance in conditions of limited productivity: slow rates of growth, evergreen habit, long-lived organs, less frequent flowering than normal, low fertility and the presence of mechanisms which allow the intake of resources during temporarily favourable conditions. In addition, there is an important variability: except for *Genista scorpius*, *Sanguisorba minor*, *Plantago serpentina*, *Campanula speciosa* and *Pinus sylvestris*, the remaining 64 species occur in fewer than the half of the relevés, and generally only in 1 or 2.

Thalweg vegetation (VIII)

The thalwegs on the Cretaceous clays are not so pronounced as those on marls, and rarely hold thick depositions of debris. Thus, although the

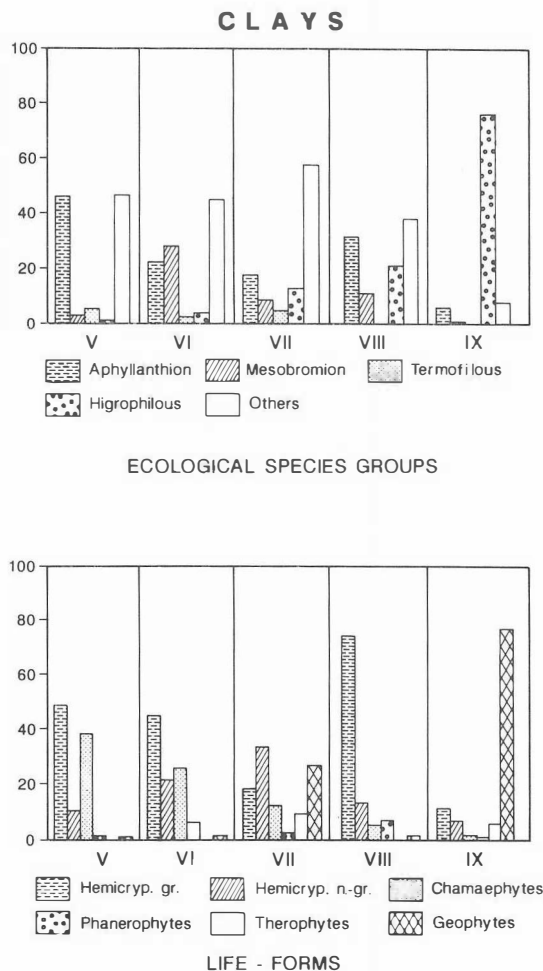


Fig. 7 - Percentage cover of species of Cretaceous clays classified according to ecological significance and to life-form .

community of these thalwegs has higher coverage and diversity than those on the slopes, floristic differences are smaller than on Eocene marls. The graminoid type dominates (74.1%), and *Aphyllanthion* species are more abundant here (31.0% cover), this being one of the reasons for the weaker differentiation of the Cretaceous thalweg community.

Tussilago farfara community (IX)

Sometimes, when the footslope ends in a stream, a hygrophytic and clay-related community takes place. It is a very poor one, mainly with *Tussilago*



Fig. 8 - General view of a badland in Cretaceous clays. Detached sliding turfs in the upper part of slopes can be observed.

farfara, a rhizomatous herb capable of rapid vegetative spread, and well-adapted to the compact and anaerobic soils. The remaining species have very low covers, normally only one or two individuals being present in each plot, and do not have an homogeneous ecological significance.

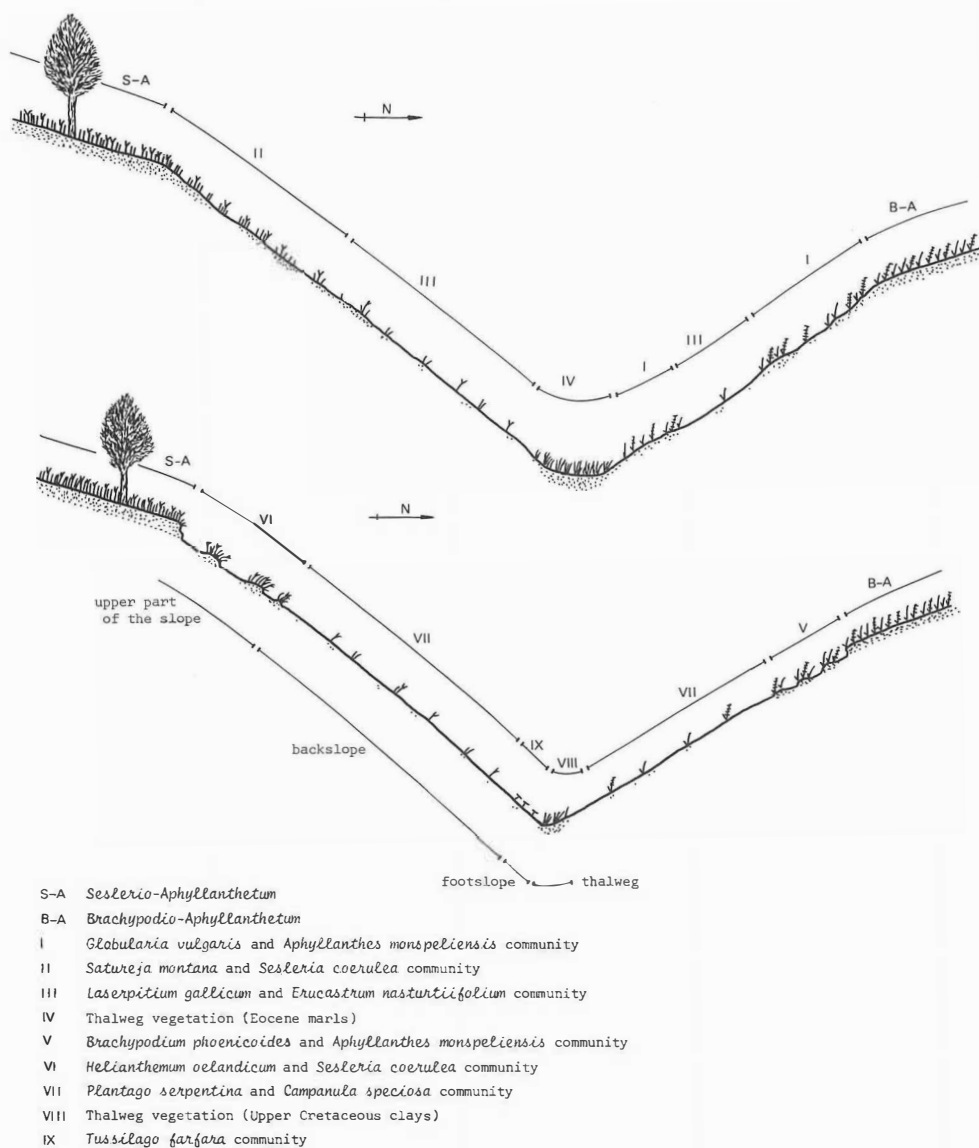


Fig. 9 - Idealized cross-section of a marl badland (top) and a clay one (bottom). Along the slopes a regressive transition going from initial pastures (*Seslerio-Aphyllanthetum* on north-facing exposures, *Brachypodio-Aphyllanthetum* on south-facing ones) takes place through several less dense communities. Note, in the clay badland, the sudden transition between pastures and badland communities, the more extensive backslope communities and the sharper thalweg.

Discussion

As a general feature, the vegetation inhabiting the badlands is always very scattered and heterogeneous. It is closely related to that of the non-eroded neighbouring zones. The erosive processes that lead to the formation of the badlands seem to involve a regressive succession going from pastures or light pine forests to less complex communities, ending in most cases in a complete lack of vegetation. Along this succession, most of the species gradually become rare and eventually disappear, because of the general loss of soil (decrease of water availability, etc.), the direct uncovering of roots or the falling downhill of turfs. Although in the study area disturbed lands are easily colonized by opportunist species, these plants are not very important in the badlands, probably because the substratum instability renders impossible the permanence of the seed pool needed for their persistence.

The badland vegetation is normally herbaceous or low shrubby, those with a light tree layer of *Pinus sylvestris* (or *P. sylvestris* X *uncinata*) being very rare. However, as this pine has a strong settling power and is the commonest tree in the area, it is a very frequent species in the badlands in the form of seedling or sapling, with extremely low growing rates.

Badland development includes a wide range of erosive processes: rainplash, sheet wash, concentrate flow, etc. (Bryan & Yair 1982). The relative importance of these processes varies according to the topographic position in the badland. As these processes clearly determine the vegetation through the higher or the lower tolerance of each species, the topographic position is the most influential factor in the distribution of the communities in each badland. Brown (1971) related the distribution of seven plant communities in Montana Badlands to soils and physiographic characteristics. He concluded that distribution of plant communities in the badlands is determined by topographic and edaphic factors to the extent that they influence the availability of soil water. In North Dakota Badlands, Butler (1986) found that landscape position was correlated with vegetation composition, standing crop and soil characteristics, including soil moisture.

Some differences can be observed between the Eocene and the Cretaceous relevés. Generally, Cretaceous clays badlands present more extensive bare surfaces than Eocene marls. Besides that, in the colonized patches the plant cover is usually lower in the former, and abnormally growing plants are more frequent. The clayish nature of the Cretaceous materials allows the formation of a superficial crust, which makes stabilization and germination of seeds very difficult. Moreover, the badland morphology is not the same in the two substrata, allowing differences in the type and extension of several features (steepness, length of slopes, width of thalwegs, etc.). On the other hand, the Cretaceous badlands as a whole are located at slightly higher altitudes than the

Eocene ones, and this should be connected with the fact that the former bear communities which are slightly more mesophilous than the other.

Conclusions

The communities inhabiting the studied badlands are closely related to those of the neighbouring pastures. They represent a regressive succession from vegetation on neighbouring slopes. They are the result of the degradation of such original communities by loss or decrease of species, generally the mesophilous ones. Although in the study area disturbed lands are easily colonized by opportunist species, these plants are not very important in the badlands. Unstability and features of the rhelogit seem to be the main constraints for their settlement.

Topographic position and the related dynamics of the erosive processes are the most influential factors in the distribution of plant communities in each badland.

In the upper part of slope, vegetation is still fairly related to the initial pasture, through a gradual transition in the Eocene marls and a sharper one in clays.

Steeper backslopes are the harshest environments, especially on Cretaceous clays where bare surfaces are so extended. Vegetation cover is lower than elsewhere and abnormal-growing plants are frequent.

Downhill, talwegs are the relatively most favourable places, mainly on Eocene marls where a dense herbaceous layer with several mesic species can be observed.

Marls and clays badlands hold some vegetation differences mainly connected to altitude and morphology of the badlands.

Acknowledgements

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THE ROLE OF *ALNUS GLUTINOSA* (L.) GAERTNER IN THE SECONDARY SUCCESSION ON WET MEADOWS IN THE PINÉ HIGH PLAIN (NORTH ITALY)

Dan GAFTA & Roberto CANULLO

Keywords: Abandoned meadows, *Junco-Molinietum*, Seedlings, Population structure, Vegetation dynamics.

Abstract: Four main successional stages in the abandoned mowed meadows belonging to *Junco-Molinietum* association are evidenced by means of a structural study of the colonizing tree species, and especially for the black alder. The gradual decrease in soil humidity and the formation of high tufts of *Molinia* make possible only the vegetative propagation of the black alder and the penetration of mesophilous tree species. Under the alder wood, corresponding to the third stage of the succession, natural renovation is totally lacking. However, the abundance of maple, ash and oak seedlings preludes an evident dynamism towards an *Aceri-Tilietum* forest association.

Introduction

The abandoning of agriculture in vast mountain areas in the Alps has led to radical transformation of the landscape. This phenomenon has affected cultivated fields, mowed meadows and pasturelands in which dynamic processes characteristic of secondary successions have set in.

In particular, wet meadows no longer mowed and belonging to the *Junco-Molinietum*, *Lysimachio-Filipenduletum* and *Scirpetum sylvatici* associations are being colonized by shrubs of the *Alno-Padion* alliance; these were previously widespread in more limited areas such as hedgerows and in small groupings on the steeper parts of meadows, on scarps and so on.

The purpose of this study is to evidence the transitional phase of the secondary succession covering the first three decades after the abandoning of agriculture. In particular, some successional stages are evidenced by means of a structural study of the colonizing tree species populations, above all of the black alder (*Alnus glutinosa*).

Study area

The study area is located on the western slopes of the Dosso di Costalta (Piné High Plain), between the farms of Fovo Alto (1279 m), Cospian (1052 m), and Fovi (983 m), which is the same area where phytosociological relevés have been carried out on still mowed wet meadows (Pedrotti 1988). These slopes go down fairly regularly towards the valley bottom with a

morainic substrate of porphyritic origin. To the north and south, the sector is bounded by two valleys that descend from Dosso di Costalta to Miola di Piné (Eastern Italian Alps).

Vegetation background

In the study area the vegetation climax is represented by an acidophilous beech wood (*Luzulo-Fagetum*) and by *Aceri-Tilietum* nuclei with a prevalence of *Quercus petraea* (Matt.) Liebl., which is the last expression of the two associations towards the upper altitudinal limit. Above 1200 m the natural vegetation is formed by spruce woods (*Luzulo-Piceetum*). In addition, the azonal vegetation is represented by two edaphic climax associations: *Agropyro-Alnetum incanae*, with prevalent black alder along the torrent valleys, and *Thelypteridi-Alnetum glutinosae* on marshy terrains near the Serrai Lake.

The secondary vegetation includes fertile meadows (*Centaureo-Arrhenatheretum*) on dry terrains and wet meadows (*Junco-Molinietum* and *Scirpetum sylvatici*) on terrains permanently moistened by deep drainage waters and by springs (Pedrotti 1988).

Many authors have reported the colonization of *Molinia coerulea* (L.) Moench meadows with *Alnus glutinosa* and/or *A. incana* (L.) Moench, according to the altitude and to the local climatic conditions: Richard (1970) for the northwestern Alps, Ledi (1921) for the Swiss Alps, Seibert (1962) for the Bavarian pre-Alps, Kovacs (1962) for the Pannonian Plain, etc. Also in the Trentino region, a general characteristic is the settling of hygrophilous pioneer species in abandoned wet meadows (Pedrotti & Chemini 1981, Pedrotti 1988, Venanzoni 1988). This phenomenon has been interpreted by Falinski (1966, 1986) as an indication of the relative young age of the anthropic landscape and as an expression of a strong tendency for the original vegetation to return.

However, there are some differences regarding the participation of the black and white alder. For example, in the Val di Fiemme (Gafta 1990) and in the Valle di Chieppena (Pieczerak 1988), *Alnus incana* has an exclusivity, or almost so, due to a climate tending to continental-type in the Lagorai mountain chain. Conversely, in the study area the black alder seems to be at an advantage in competition with the white alder, even at altitudes of 1000-1150 m; that can be explained by the oceanic influence as evidenced by the Gams index of 44.25° calculated for Le Piazze station (Gafta 1990) and by the presence of beech trees.

Methods

Four distinct areas corresponding to four stages of the succession were analyzed: Stage 0 with mowed meadows of *Junco-Molinietum*; Stage 1 with isolated shrubs; Stage 2 with groupings of shrub or sapling; Stage 3 with

complete tree cover. The Stage 1 area lies in a vast clearing surrounded by spruce plantations and inside which anthropic impact (building of a road, larch plantations and tree felling) has modified the ground water system, thereby favoring penetration of species of the order *Arrhenatheretalia* and *Nardetalia* and of common pioneer trees such as *Salix caprea* L. and *Populus tremula* L. Despite the data being influenced by the action of man, the meadows in Stage 1 have been considered a qualitative baseline.

In each of the areas chosen, population inventories of the various colonizing forest species were made in the whole surface in question or else, depending on sample size, only in transects with a view to then proceeding to identification, counting, and dendrometric measuring of individual trees. In each bush of vegetative origin all the suckers and the height of the oldest shoot were measured.

Meanwhile, inside the sample area, the horizontal distribution of the seedlings was evidenced by a grid of $0.5 \times 0.5 \text{ m}^2$ squares arranged both over the whole surface and on the diagonals.

The dispersion coefficient was calculated by means of the ratio of the variance and the mean:

$$d = \frac{\sum(x - \bar{x})^2}{\bar{x} (n-1)}$$

where "x" is the density of each square, " $\bar{x}$ " the mean density and "n" the number of squares (Kershaw 1973).

The instantaneous humidity of the soil was evaluated for all four stages at the end of August, extracting samples from a depth of 15 cm and then weighing them in the wet and dry states.

The minimum time elapsing from the abandoning of the meadows was calculated by determining the maximum age of the individual trees present.

Results

Stage 0

This is a small area with a 9° slope covered by a still mowed meadow of the *Junco-Molinietum* association that, however, assumes the form of a relatively dense pelouse. A complete inventorying of the 396 squares revealed a vast *Alnus glutinosa* population with a frequency of 33%. The distribution coefficient was 14.5 and showed a clustered horizontal distribution, above all in

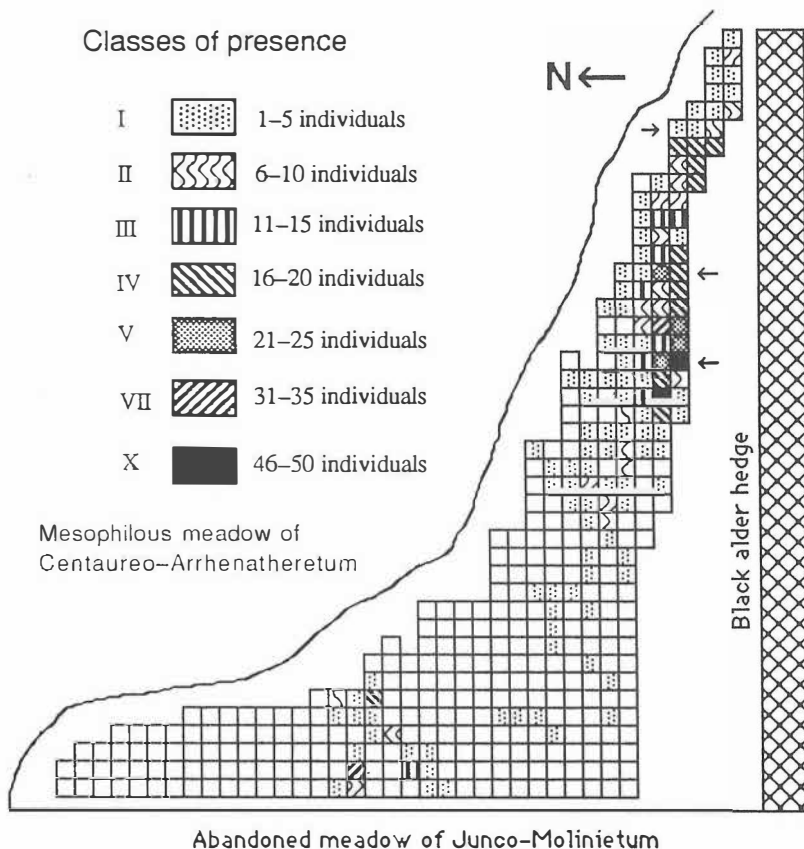


Fig. 1 - Horizontal distribution of the presence of *A. glutinosa* specimens, site of the 3-squared sample along the humidity gradient, and insertion of the mowed meadow (Stage 0) in the local vegetation background.

the upper right-hand part, due to three factors: the humidity of the soil being almost three times higher than that at the lower edge of the meadow (Table I), the existence of a small ditch in the right-hand part and the shade afforded by the alder hedgerow at the edge (Fig. 1). The age of the black alder specimens was between 5 months and 3 years, and the tops of the stems of the oldest appeared to have been mowed down at least once.

Also the *Acer platanoides* L. seedlings played a relatively important role in the initial colonization; these have a 17% frequency and are always concentrated in the more humid part towards the edge of the neighbouring wood. The appearance of plants of three other species [*Picea abies* (L) Karsten, *Frangula alnus* Miller and *Prunus avium* L.] can be considered negligible (Fig. 2).

Table I – Mean values of summer edaphic moisture into the four studied areas

Stage	Site of soil-sample	Absolute moisture (g. water/100 g. soil)
0	Upper part	71.86
	Lower part	24.23
1	Middle of transect A	14.72
	Middle of transect B	19.94
	Middle of transect C	15.27
2	Under the <i>Alnus glutinosa</i> bushes	42.83
	Under the <i>Molinia coerulea</i> tufts	32.74
3	Diagonals-crossing	23.41

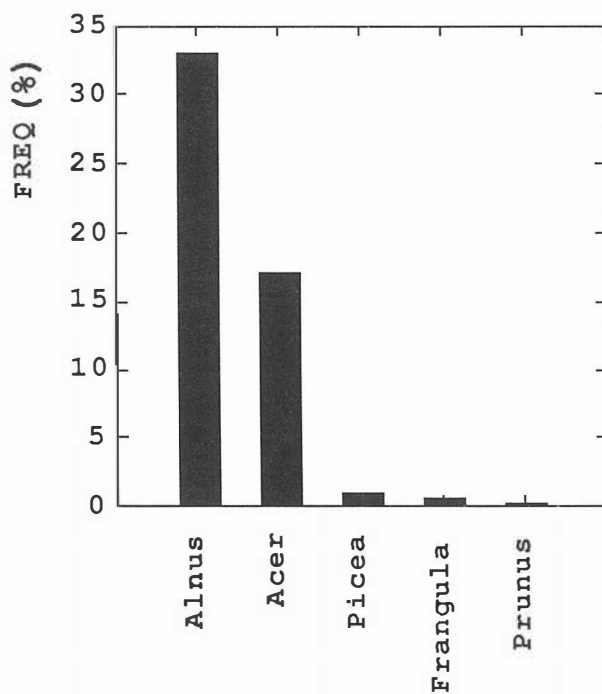


Fig. 2 - Frequency distribution of specimens of various tree species in the studied mowed meadow (Stage 0).

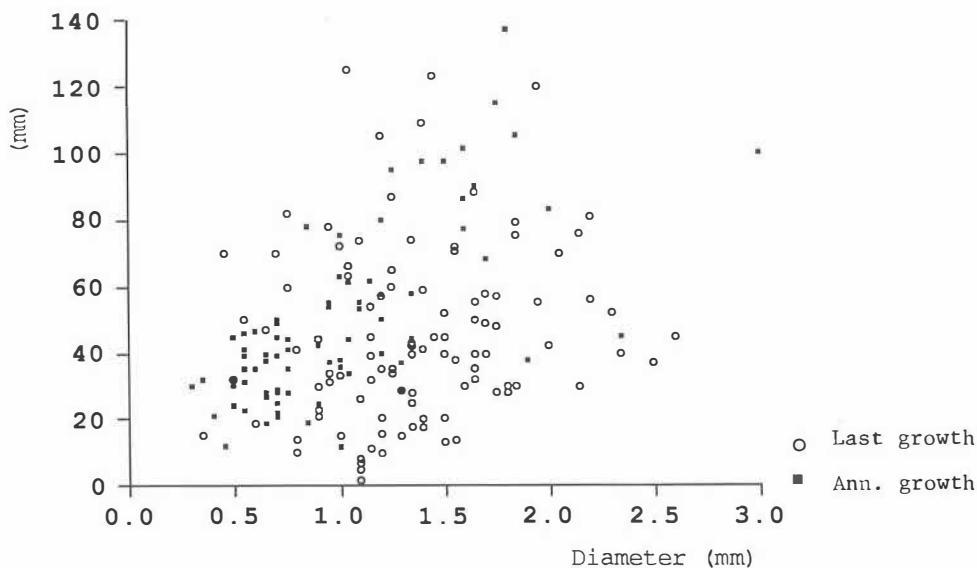


Fig. 3 - Relationship between annual lengthening and that after the last mowing with respect to diameter for individuals of *A. glutinosa* in Stage 0.

The mean density of the plants (the 5 species taken together) over the whole area is 11 m^{-2} .

On the whole surface of the meadow there is an almost continuous mossy layer which favours the germination of seeds of hygrophilous tree species. Many black alder seedlings have wounds on their bark due to precocious and late frosts; however, growth in height remains active when the terminal shoot is cut and a certain tendency to increased diameter growth can be noted (Fig. 3). The variation coefficient of the diameter thus attains a high value of almost 93%.

Of all the dendrometric elements measured, the height of the saplings (of age less than one year) shows relatively more homogeneous values (C.V. = 37%) because they have not been mowed down (Table II). The mean annual and post-mowing lengthening values show that the latter could even equal the former, in that the mowing was done in May and the measurements were made at the end of August.

The intensity of lengthening, expressed as seedling height is certainly proportional to the edaphic humidity, as can also be noted from the example illustrated in Fig. 4 for the three sample squares sited along the humidity gradient (Fig. 1).

Stage 1

For the second phase of the succession a meadow abandoned for at

Table II – Statistical indices for the set of dendrometric data regarding *A. glutinosa* individuals in Stage 0.

Indexes	Diameter	Ann. growth	Height	Last growth
N. of cases	954	75	763	106
Minimum (mm)	0.100	12.000	10.000	1.600
Maximum(mm)	3.000	137.000	102.000	125.000
Range (mm)	2.900	125.000	92.000	123.400
Mean (mm)	0.473	49.387	29.387	44.968
Variance	0.193	698.592	118.671	679.042
Standard dev.	0.440	26.431	10.894	26.058
Variation coefficient (%)	0.929	0.535	0.371	0.579

least 15 years was chosen, with isolated clumps of *Alnus glutinosa*, *Alnus incana*, *Betula pendula* Roth, and sometimes even *Populus tremula* and *Salix caprea*. The releves were carried out inside 3 transects having a mean slope of 10° (Fig. 5). Almost all the shrubs originate from the stumps remaining after repeated felling. The frequency distribution for the tree species shows *Alnus incana* in the

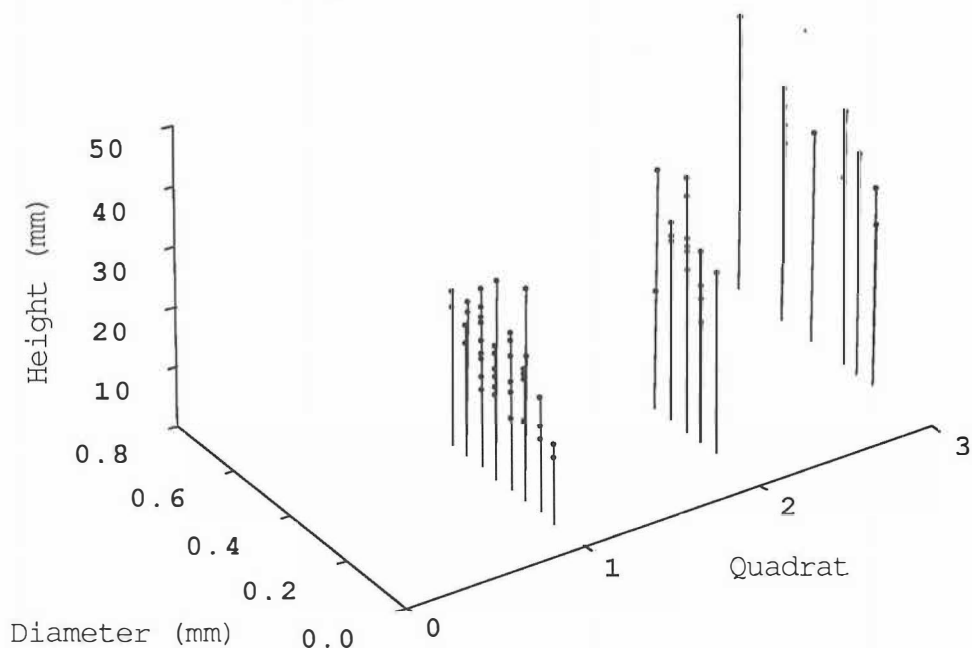


Fig. 4 - Variations in height of *A. glutinosa* seedlings situated in three sample squares (cf. Fig. 1) along the positive edaphic humidity gradient.

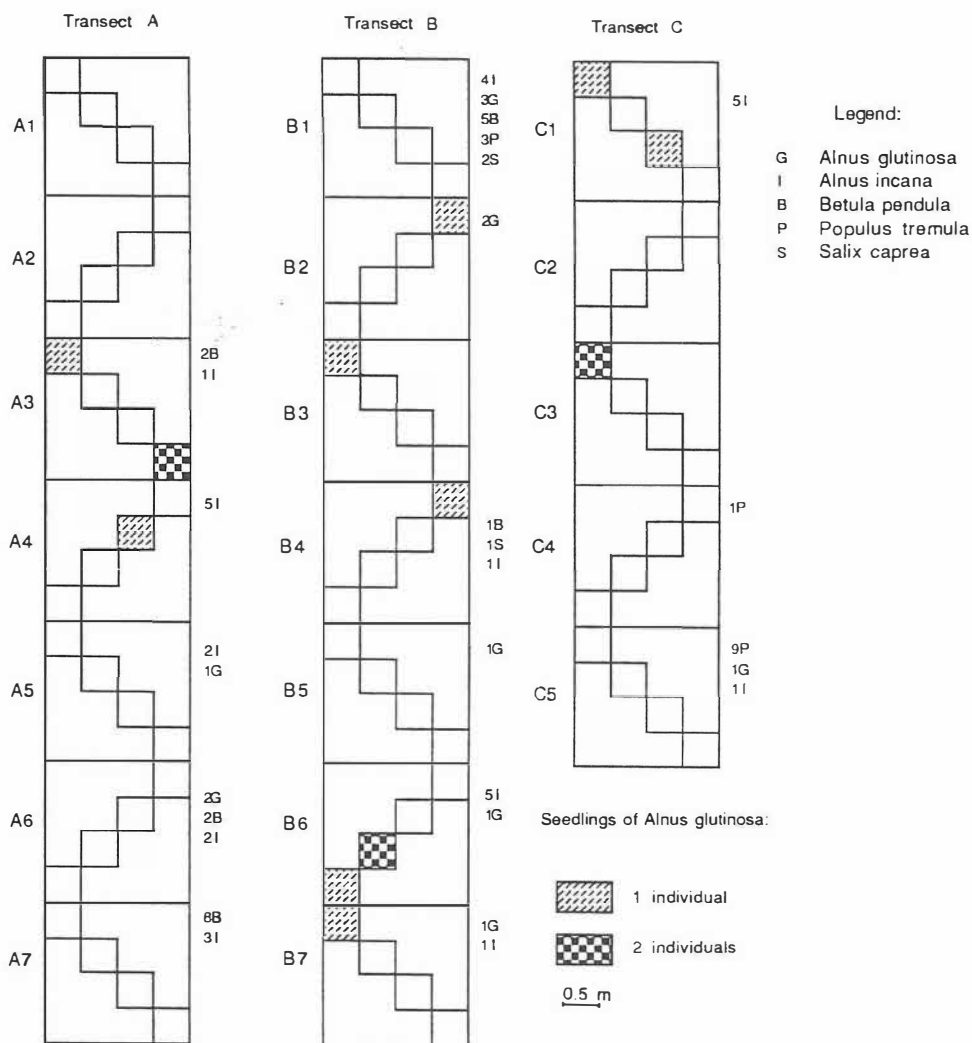


Fig. 5 - Presence of individuals of various colonizing species in squares A(1-7), B(1-7), C(1-5), and presence of seedlings in the diagonally placed subareas inside the 3 transects fixed in the abandoned meadow of Stage 1.

first position, even though black alder saplings are more numerous than those of white alder (Fig. 6); in fact, the same order of species is maintained also for shoots abundance. This is probably due to the greater capacity of *Alnus incana* to resist under conditions of scarce edaphic humidity (Schwabe 1985).

In the first years the maximum shoot height of an *A. incana* stump

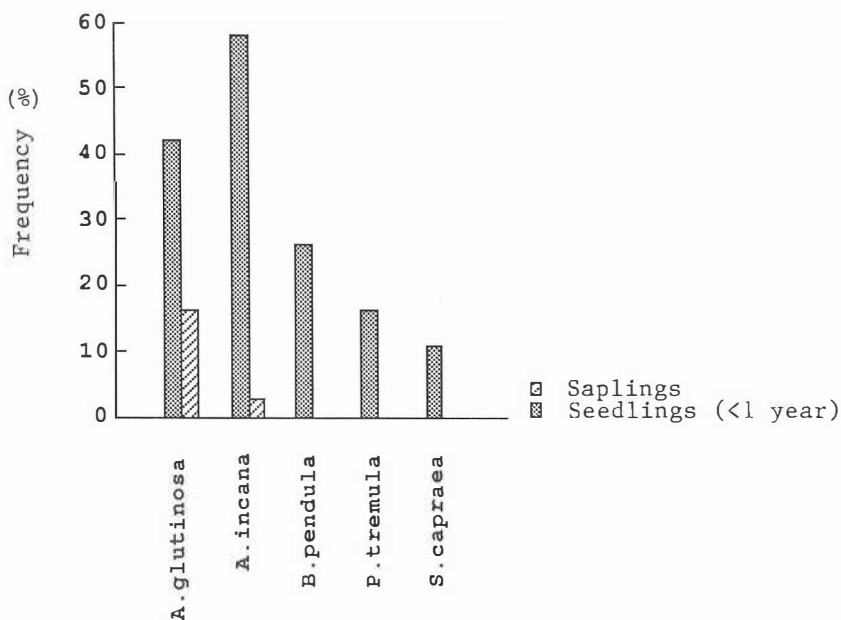


Fig. 6 - Frequency distribution of seedlings belonging to the various colonizing tree species (Stage 1).

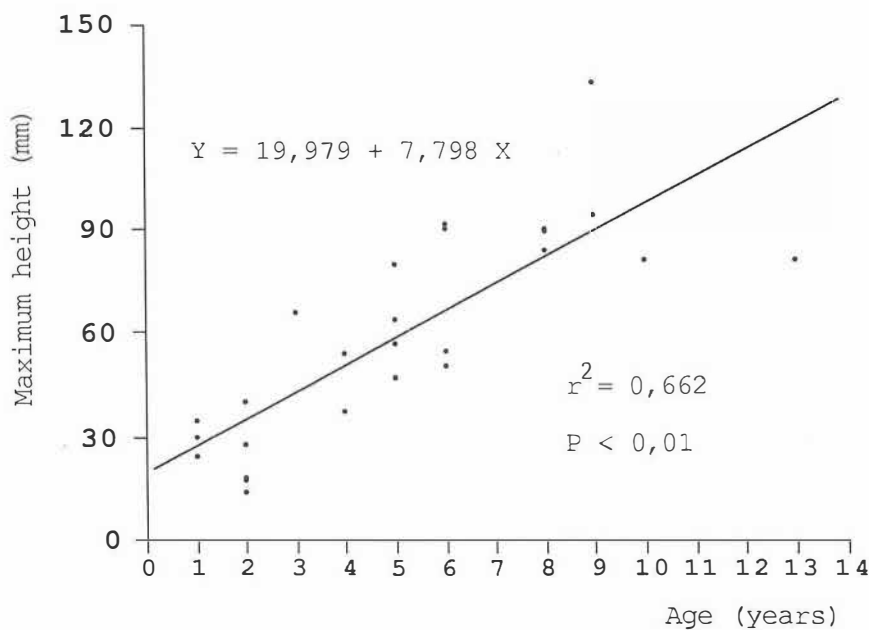


Fig. 7 - Correlation between age and height of dominant shoot in *A. incana* shrubs (Stage 1). The curve represents the best approximation obtained using the least-squares method.

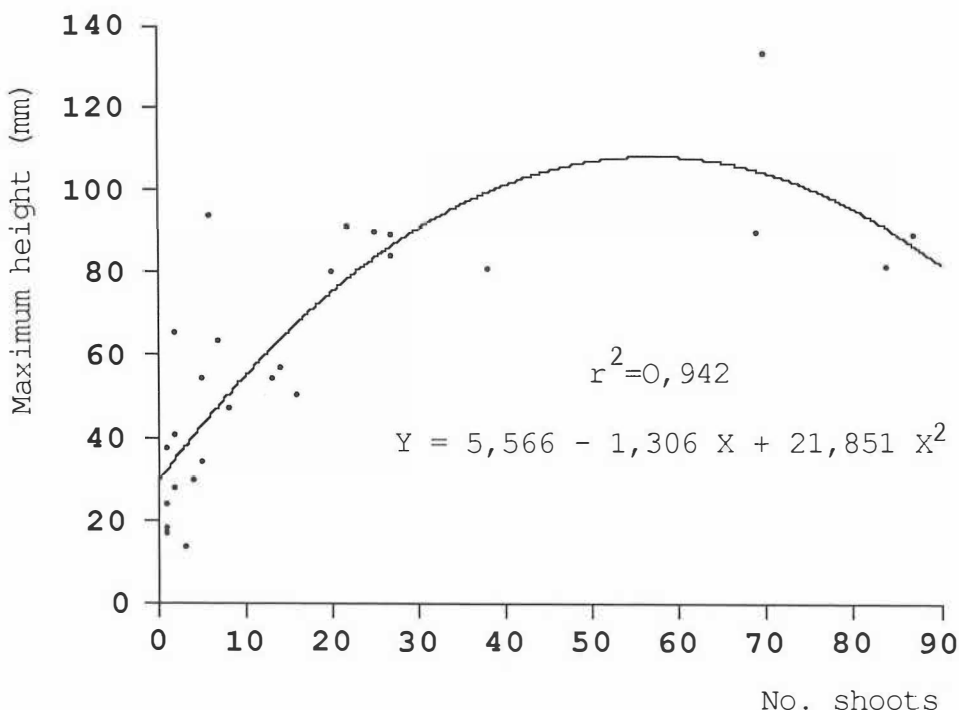


Fig. 8 - Correlation between the number of shoots per shrub and the height of the dominant shoot for *A. incana* (Stage 1). The curve represents the best approximation obtained using the least-squares method.

grows on average linearly with age (Fig. 7). The correlation between the number of shoots per stump and the maximum height is of the quadratic type, since at a certain moment the nutritional requirements of the suckers become more than the absorption capacity of the stump (Fig. 8).

Generative reproduction is less frequent due to tufts of *Molinia coerulea* and other herbaceous species completely covering the ground, and to the lower level of edaphic humidity in summer (Table I). The sapling frequency is, therefore, only 17% with a mean density of 4 saplings/m². The high percentage of *Salix caprea* and *Populus tremula* is partly due to the meadow being in a large clearing facing southwest and therefore subject to more insolation.

Stage 2

The characteristics of this successional stage were analyzed in a meadow abandoned for at least 25 years on a terrain sloping 6°.

Above all, a very clustered distribution of *Alnus glutinosa* can be noted, a species that acquires exclusivity (Fig. 9). The mean number of shoots

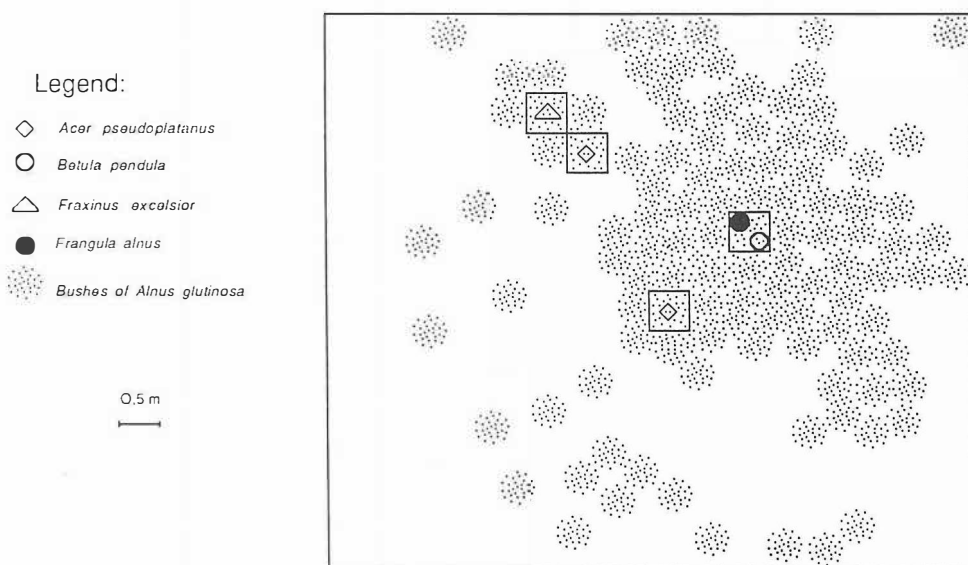


Fig. 9 - Seedling distribution of various tree species and of *A. glutinosa* shrubs in the abandoned meadow (Stage 2).

per shrub is 6, and considerably dense shrubs (with up to 32 suckers) are infrequent. The distribution of the number of individuals decreases logarithmically with the classes of the number of suckers per shrub (Fig. 10), and thus the meadow is dominated by specimens having few but high suckers emerging from among the numerous other surrounding ones. However, no significant correlation was found between the number of shoots per shrub and the height of the dominant shoot.

The tufts of *Molinia coerulea* (up to 20-30 cm high) give the impression of a disconnected terrain. The slow decomposition of organic remains determines the accumulation of a 5-6 cm thick superficial organic horizon. In these conditions the establishing of new saplings becomes almost impossible; in fact, their frequency (2.2%) and mean density (0.1 saplings/m²) are very low. Saplings are composed only of *Acer pseudoplatanus*, *Betula pendula*, *Fraxinus excelsior* L. and *Frangula alnus*, and are concentrated below the alder groups (Fig. 9) where the mineral soil crops out at the surface and the edaphic humidity is 31% higher than in soil covered with *Molinia* tufts (Table I).

Black alder essentially spreads thanks to vegetative propagation which is also enhanced by the death, due to frost, of young branches.

Stage 3

The last stage observed in the studied succession is a monospecific wood of

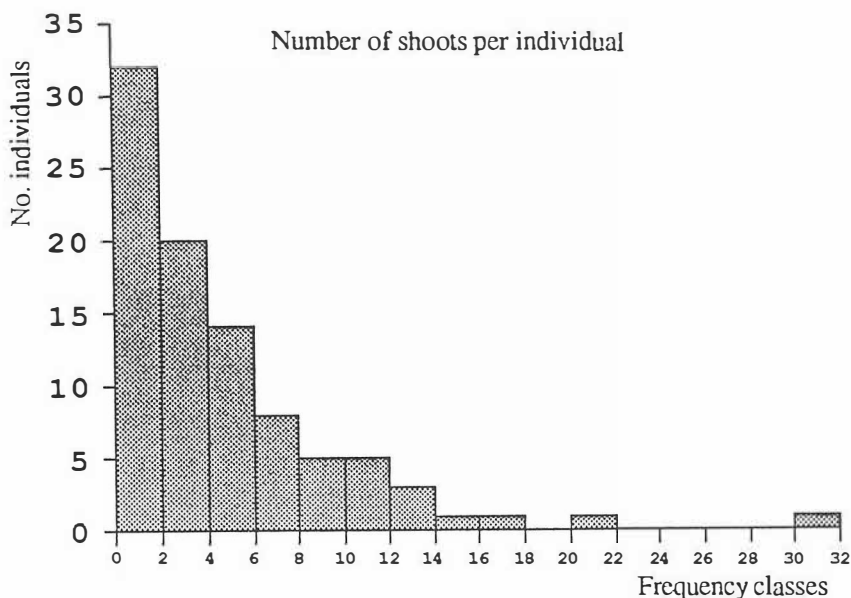


Fig. 10 - Distribution of the number of *A. glutinosa* shrubs according to the number of shoots expressed in frequency classes (Stage 2).

Alnus glutinosa not coetaneous in structure. This wood evolved from a meadow that had been abandoned for at least 30 years, situated on a terrace with 10° slope. The trees form a closed vault reaching an average height of 10 m. Consequently, the brushwood layer has a low cover and is poor in species, the most frequent of which are *Equisetum sylvaticum* L. and *Lysimachia vulgaris* L. The moss layer is completely lacking on account of the biological drainage due to the edaphic humidity being reduced by 51% with respect to that of the initial stage (Table I).

For the black alder there is no generative and vegetative renovation, although for other species this is very active. Subsequent to the inventorying along the diagonals of the sample square, a high number of seedlings was recorded, above all in the moister up-slope part. A mean density of 6 seedlings/m² was found, the dominant ones being maples which display a high level of vitality. Spruce seedlings are attributable to the presence of plantations with *Picea abies* in the neighbourhood of the study area. The frequency distribution of the seedlings belonging to the various species is reported in Fig. 11.

All these considerations are evidence of how the black alder wood stage is not the last one in the succession; the last is more likely to be the *Aceri-Tilietum* climax association (Mayer 1974) with considerable participation of

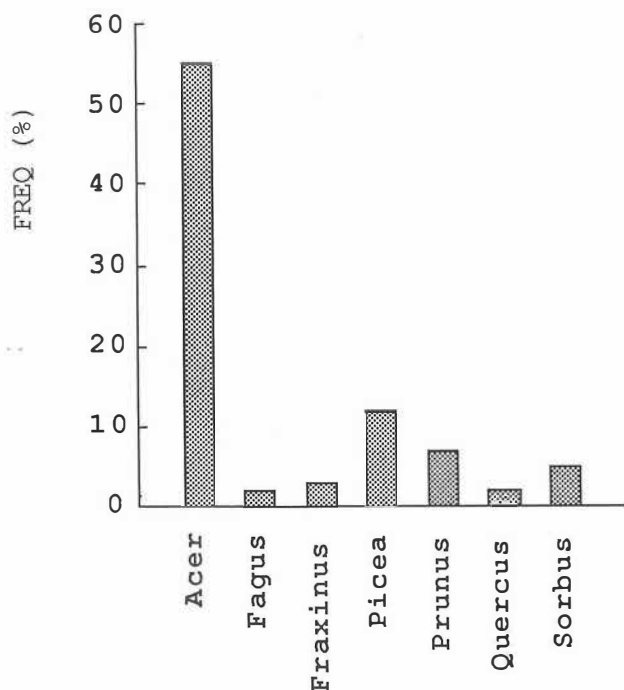


Fig. 11 - Seedling distribution frequency in the *A. glutinosa* wood (Stage 3).

Quercus petraea. This is still found as a residual form in the internal Alps, the nearest example being at Tressilla di Piné.

Conclusions

In the territory analyzed *Alnus glutinosa* proves to be a pioneer species with great capacity for propagation in abandoned meadows of the *Junco-Molinietum* association. This phenomenon is above all present near a hedge or coppice of black alder (up to a distance of 30-40 m), due to the seeds lacking in alar structure. Conversely, *Alnus incana* and *Betula pendula* form slightly winged seeds which are more easily transported by the wind; moreover, the seedlings of these species are more resistant to frost and drought in spring, which explains their abundance in the samples of Stage 1.

The constancy of *Alnus glutinosa* seedlings in meadows still subject to mowing is enhanced in microstations whose sides are sheltered by mature alders, where microclimate and insolation are optimal. Mowing is enough to inhibit the start of the successional process. After the meadow is abandoned, a gradual decrease in soil humidity is noted in summer together with an onset of

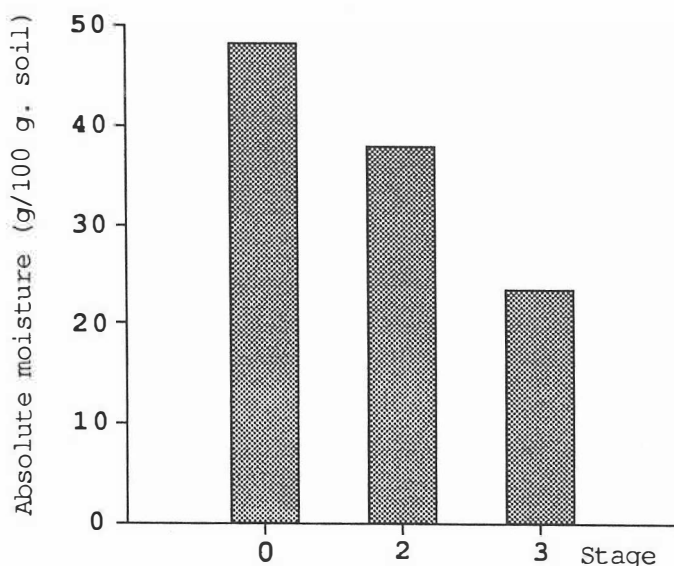


Fig 12 - Edaphic humidity levels in three examined stages.

colonization (Fig. 12) which however, favors the penetration of mesophilous tree species. This is also confirmed by rlvcs carried out by Pedrotti (1988) in the same territory. In addition, the formation and relative enlargement of *Molinia coerulea* tufts is observed; this lasts until the forest mantle is formed, at which point it gradually ceases due to insufficient light. The few specimens existing in the ground cover are sterile.

Since the dry *Molinia* leaves form a very consistent layer of incompletely decomposed organic remains, tree species can spread only vegetatively. Under the alder wood corresponding to Stage 3 natural renovation is totally lacking, probably due to hydric changes in the soil and to the tannin-rich litter which destroys the seedlings (McVean 1955-1956). The wet meadows in the area settle in stations where the hydric regime of the soil is affected by running and non-stagnant waters, not at all the optimal ecological conditions for the black alder. The *Alnus glutinosa* forest stage probably does not, therefore, constitute the climax, in so far as maple, ash, and oak renovation precludes an evident dynamism towards *Aceri-Tilietum*. Thus, the alder wood in question, although being young and not coeval, is destined to disappear rather rapidly under natural conditions, i.e. without anthropogenic action.

Riassunto

L'abbandono delle pratiche agricole in vaste aree montane delle Alpi ha determinato l'avvio dei processi dinamici caratteristici delle successioni secondarie. In particolare, i prati umidi non più falciati appartenenti all'associazione *Junco-Molinietum* vengono colonizzati da arbusteti dell'alleanza *Alno-Padion*. Scopo del presente lavoro è quello di mettere in evidenza la fase transitoria della successione compiuta da *Alnus glutinosa*, che copre i primi 3 decenni dopo la cessazione dello sfalcio. Sono state analizzate 4 aree distinte, che corrispondono ad altrettante tappe della successione: stadio a prato falciato di *Junco-Molinietum* (0), stadio a prato abbandonato con cespugli isolati di arbusti (1), stadio con aggruppamenti di cespugli (2) e stadio a bosco chiuso (3).

La costanza di *Alnus glutinosa* nei prati umidi della zona indagata dimostra che esso è avvantaggiato nella concorrenza con *Alnus incana* anche ad altitudini di 1000-1150 m, probabilmente a causa del clima con influenze oceaniche (indice di Gams di 44,25"). Dopo l'abbandono del prato si nota una diminuzione graduale dell'umidità estiva del suolo, contemporaneamente all'avanzata della colonizzazione, che però favorisce la penetrazione delle specie arboree mesofile. Dal momento che le foglie secche di *Molinia* formano uno strato molto consistente, la diffusione dell'ontano nero si può realizzare soltanto per via vegetativa. Siccome il regime idrico del suolo influenzato dalle acque scorrenti non costituisce l'ottimo ecologico per l'ontano nero, lo stadio a bosco puro di *Alnus glutinosa* non dovrebbe rappresentare il climax. La composizione del novellame prelude infatti ad un evidente dinamismo verso l'*Aceri-Tilietum*.

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NOMENKLATORISCHE REVISION DER ILLYRISCHEN BUCHENWÄLDER (VERBAND AREMONIO-FAGION)

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Igor DAKSKOBLER & Marko ACCETTO

Keywords: Austria, beech woods, Bosna and Hercegovina, Croatia, Friuli-Venezia Giulia, Hungary, Illyricum, nomenclature, Slovenia, syntaxonomy.

Abstract: A nomenclatural revision of the Illyrian beechwoods of Slovenia, Croatia, southwestern Hungary, southern part of Carinthia (Austria) and northeastern part of Italy (Veneto and Friuli Venezia-Giulia) is presented. Some beechwoods from Bosnia and Herzegovina as well as Montenegro have also been considered. The names of the *Aremonio-Fagion*, 4 suballiances as well as 22 associations have been revised, nomenclatural types selected and copious synonyma assigned.

Einführung

Das Ziel dieses Beitrages ist, die syntaxonomische Nomenklatur der Vegetationseinheiten im Rahmen des *Aremonio-Fagion*, bisher besser unter dem Namen *Fagion illyricum* bekannt, zu stabilisieren.

Die illyrischen Buchenwälder wurden in vielen wissenschaftlichen Arbeiten syntaxonomisch erfaßt. Zu den Klassikern zählen I. Horvat (1938, 1950), Knapp (1944) und Košir (1962, 1979) und zu den wichtigsten synthetischen Zusammenstellungen die Werke von M. Wraber (1960), Borhidi (1963, 1965, 1966a, 1966b), Soó (1964), Horvat, Glavač & Ellenberg (1974), Fukarek (1977), Jovanović, Jovanović & Zupančič (1986), Bertović & Lovrić (1987), Marinček (1987), Török, Podani & Borhidi (1989) und Mucina (in Wallnöfer, Mucina & Grass 1993).

Beschreibungen einzelner Assoziationen und relevanter höherer Syntaxa aus Slowenien brachten Tregubov (1957b, 1962), M. Wraber (1961, 1966), Zupančič (1967, 1969), Puncer, Wojterski & Zupančič (1974), Puncer (1979, 1980), Marinček (1980a, 1980b, 1981, 1983, 1988), Marinček & Zupančič (1977), Marinček, Puncer & Zupančič (1983), Cimperšek (1988), Marinček & Dakskobler (1988), Marinček, Poldini & Zupančič (1989), Marinček et al. (1990), Dakskobler (1991) und Zupančič & Puncer (1993).

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In der kroatischen, bosnischen und montenegrinischen pflanzensoziologischen Literatur wurden diese Wälder von z. B. Tregubov (1941), Blečić (1958), I. Horvat (1962), Fabijanić, Fukarek & Stefanović (1963), Fukarek, Stefanović & Fabijanić (1967), Fukarek (1969, 1970), Tomić-Stanković (1970), Trinajstić (1972), Pelcer (1978), Pavletic, Šugar & Trinajstić (1982) behandelt.

Am Rande des Verbreitungsareals, im ungarischen Mecsek (A.O. Horvát 1959, 1972, 1977), in Transdanubien (Borhidi 1960) und in Österreich wurde dem Verband *Aremonio-Fagion* in Werken von Aichinger (1933), Pignatti (1966) und Zukrigl (1988, 1989) Aufmerksamkeit gewidmet. In Friaul-Julisch Venetien und im Veneto studierte diese Wälder Mayer & Hofmann (1969) sowie Poldini & Nardini (1993).

Das System

Die Gruppe umfaßt eine große hypsometrische Spanne (von submontanen bis zu subalpinen Lagen) illyrisch-dinarischer Buchenwälder. Der Verband *Aremonio-Fagion* zerfällt in 4 Unterverbände und 22 Assoziationen, was in folgendem hierarchischem System zusammengefaßt wird:

Aremonio-Fagion (I. Horvat 1938) Török, Podani et Borhidi 1989

Epimedio-Fagenion Marinček et al. 1993

Hacquetio-Fagetum Košir 1962

Vicio oroboidi-Fagetum (I. Horvat 1938) Pócs et Borhidi in Borhidi 1960

Helleboro odori-Fagetum (A.O. Horvát 1959) Soó et Borhidi in Soó 1962

Melico mutantis-Fagetum Fabijanić, Fukarek et Stefanović ex Marinček et al. 1993

Ornithogalo pyrenaici-Fagetum Marinček et al. 1990

Lamio orvalae-Fagenion Borhidi ex Marinček et al. 1993

Lamio orvalae-Fagetum (I. Horvat 1938) Borhidi 1963

Arunco-Fagetum Košir 1962

Isopyro-Fagetum Košir 1962

Cardamine savensi-Fagetum Košir 1962

Lamiasastro flavidi-Fagetum Zukrigl ex Marinček et al. 1993

Omphalodo-Fagetum (Tregubov 1957) Marinček et al. 1993

Saxifrago rotundifoliae-Fagenion Marinček, Poldini et Zupancič ex Marinček et al. 1993

Polysticho lonchitis-Fagetum (I. Horvat 1938) Marinček in Poldini et Nardini 1993

Anemono trifoliae-Fagetum Tregubov 1962

Stellario glochidispermae-Fagetum (Zupančič 1969) Marinček et al. 1993
Ranunculo platanifolii-Fagetum Marinček et al. 1993
Dentario pentaphylli-Fagetum H. Mayer et A. Hofmann 1969
Aconito paniculati-Fagetum (Zupančič 1969) Marinček et al. 1993
Homogyno sylvestris-Fagetum Marinček et al. 1993

Ostryo-Fagenion Borhidi 1963

Ostryo-Fagetum M. Wraber ex Trinajstić 1972
Seslerio autumnalis-Fagetum M. Wraber ex Borhidi 1963
Erico-Fagetum I. Horvat ex Trinajstić 1972
Aceri obtusati-Fagetum Fabijanić, Fukarek et Stefanović ex Fukarek, Stefanović et Fabijanić 1967
Hemerocallido lilio-asphodelo-Ostryetum Poldini 1982

Nomenklatur und Beschreibungen der Syntaxa

Im folgenden wird die Synonymisierung und Typisierung des *Aremonio-Fagion* und der untergeordneten Syntaxa beschrieben. Einige neue Syntaxa werden beschrieben, wobei die höheren Syntaxa mit Listen der Kenn- und Trennarten ausgestattet werden. Der Begriff der transgressiven Kennart (transgr.) richtet sich nach Mucina (1993), genauso wie die Untergliederung von "Synonymen" (Syn., Syntax. Syn., Inkl., Pseudonym, Phantomname, Non). In Klammern werden die Artikel des Codes der pflanzensoziologischen Nomenklatur (Barkman, Moravec & Rauschert 1986) angeführt, welche die Zugehörigkeit zur entsprechenden Kategorie der "Synonyme" erklären.

***Aremonio-Fagion* (I. Horvat 1938) Török, Podani et Borhidi 1989**

Basionym: *Fagion illyricum* I. Horvat 1938 (Art. 34) Syn.: *Carpino-Fagion illyricum* Borhidi 1963 p.p. (Art. 3b, 29) *Fagion illyricum* Borhidi 1963 (Art. 34), *Fagion austroalpinum* Fukarek 1979 (Art. 8, 34) Inkl.: *Primulo-Fagenion* Borhidi 1963 p.p.min., *Saxifrago rotundifoliae-Fagenion* Poldini in Zukrigl 1988 (Art. 8), *Saxifrago rotundifoliae-Fagenion* Poldini in Zukrigl 1989 (Art. 8), *Lonicero-Fagenion* Borhidi 1963 (Art. 3b, 36), *Lonicero-Fagenion* Oberd. et T. Müller 1984 p.p. min. (Art. 5, 36) Non: *Aremonio-Fagion* Gentile 1969 (Art. 8).

Nomenklatorischer Typus: *Lamio orvalae-Fagetum* (I. Horvat 1938) Borhidi 1963, Lectotypus hoc loco.

Nomenklatorische Bemerkung: Der Name *Aremonio-Fagion* von Gentile (1969: 278-279) bezieht sich auf die süditalienischen Buchenwälder (für eine numerisch-syntaxonomische Bearbeitung siehe Feoli & Lagonegro 1982) und

wurde ohne ausreichende Diagnose veröffentlicht (keine gültig veröffentlichte Assoziation wurde in der Diagnose erwähnt; Art. 8).

Kenntaxa: *Anemone trifolia* (transgr.), *Aremonia agrimonoides*, *Calamintha grandiflora*, *Cardamine trifolia*, *Cyclamen purpurascens*, *Dentaria enneaphyllos*, *Euphorbia carniolica*, *Helleborus niger* subsp. *niger*, *Omphalodes verna*, *Rhamnus fallax*, *Vicia oroboides*, *Waldstenia geoides*.

Der Verband vereinigt basiphile bis neutrophile Buchenwälder Illyriens. Floristisch ist diese Einheit durch viele südosteuropäisch-illyrische Arten gekennzeichnet. Diese Wälder dienen als florensgeschichtlicher "Prototypus" der Buchenwälder Europas (Comps et al. 1991).

Epimedio-Fagenion suball. nova hoc loco

Syntax. Syn.: *Primulo-Fagenion* Borhidi 1963 p.p.

Nomenklatorischer Typus: *Hacquetio-Fagetum* Košir 1962, Lectotypus hoc loco.

Kennarten: *Epimedium alpinum*, *Geranium nodosum*, *Knautia drymeia* subsp. *drymeia*, *Vicia oroboides* (transgr.). Trennarten: *Hacquetia epipactis*, *Helleborus odoratus*, *Lonicera caprifolium*, *Primula vulgaris*, *Ruscus hypoglossum*.

Der Unterverband *Epimedio-Fagenion* umfaßt die mesophilen und subthermophilen submontanen Buchenwälder Illyriens. Diagnostisch bedeutend sind einige subthermophile Arten mit soziologischer Bindung an die illyrischen Eichen-Hainbuchenwälder.

Hacquetio-Fagetum Košir 1962

Syn.: *Fagetum silvaticae croaticum boreale montanum* I. Horvat 1938 p.p. (Art. 34), *Fagetum submediterraneum* M. Wraber 1954 p.p. (Art. 2b), *Omphalodo-Fagetum* M. Wraber 1960 (Art. 2b), *Quercio-Fagetum* Košir 1962 (Art. 36), *Asaro-Fagetum* Pignatti 1966 (Art. 2b), *Fagetum submontanum* Marinček et Zupančič 1977 (Art. 34), *Fagetum submontanum prealpinum* Marinček 1978 (Art. 1, 34), *Fagetum submontanum prealpinum* Marinček in Bertović et Lovrić 1987 (Art. 2b, 34), *Primulo vulgaris-Fagetum* Poldini in Zukrigl 1989 (Art. 5, 31) Inkl.: *Fagetum submontanum* var. geogr. *Sesleria autumnalis* Accetto 1990 (Art. 3c).

Pseudonym: *Carici-Fagetum* sensu H. Mayer et A. Hofmann 1969.

Non: *Carici-Fagetum* Moor 1952.

Nomenklatorischer Typus: Košir (1979: Tab. 9, Aufn. 6), Neotypus hoc loco.

***Vicio oroboidi-Fagetum* (I. Horvat 1938) Pócs et Borhidi in Borhidi 1960**

Basionym: *Fagetum silvaticae croaticum boreale montanum* I. Horvat 1938 p.p. (*lathyterosum*) (Art. 34) Syn.: *Fagetum subpannonicum* M. Wraber 1961 (Art. 2b, 34).

Pseudonym: "*Festuco drymeiae-Fagetum* Magic 1968" sensu Cimperšek 1988.

Nomenklatorischer Typus: I. Horvat (1938: Tab. 3, Aufn. 17), Lectotypus hoc loco.

***Helleboro odori-Fagetum* (A.O. Horvát 1959) Soó et Borhidi in Soó 1962**

Basionym: *Fagetum silvaticae mecsekense* A.O. Horvát 1959 (Art. 34) Syn.: *Melico-Fagetum mecsekense* Soó 1957 (Art. 34), *Helleboro odori-Fagetum mecsekense* Soó et Borhidi 1962 (Art. 29, 34).

Nomenklatorischer Typus: A.O. Horvát (1959: Tab. auf. S. 42-45, Aufn. 13), Lectotypus hoc loco.

***Melico nutantis-Fagetum* Fabijanić, Fukarek et Stefanović ex Marinček et al. hoc loco**

Syn.: *Melico nutantis-Fagetum* Fabijanić, Fukarek et Stefanović 1963 (Art. 3b).

Nomenklatorischer Typus: Fabijanić, Fukarek & Stefanović (1963: Tab. 7, Aufn. 3), Lectotypus hoc loco.

***Ornithogalo pyrenaici-Fagetum* Marinček, Papež, Dakskobler et Zupančič 1990**

Nomenklatorischer Typus: Marinček et al. (1990: Tab. 1, Aufn. 14), Holotypus (ausgewählt in der Originalbeschreibung).

***Lamio orvalae-Fagenion* Borhidi ex Marinček et al. hoc loco**

Syn.: *Lonicero-Fagenion* Borhidi 1963 (Art. 3b, 36), *Lonicero-Fagenion* Oberd. et T. Müller 1984 p.p. (Art. 36), *Lamio orvalae-Fagenion* Borhidi in Török, Podani et Borhidi 1989 (Art. 5).

Nomenklatorischer Typus: *Lamio orvalae-Fagetum* (I. Horvat 1938) Borhidi 1963, Holotypus hoc loco.

Nomenklatorische Bemerkung: Oberdorfer & Müller (1984) benutzen den Namen *Lonicero-Fagenion* (sensu Borhidi 1963) nicht im ursprünglichen Sinne, sondern bezeichnen mit diesem auch die nord-prealpinen Buchenwälder. Wir stimmen mit Dierschke (1990) und Wallnöfer, Mucina & Grass (1993) überein, daß die nordprealpinen und südprealpin-illyrischen Buchenwälder in getrennte Verbände gehören müssen.

Kennarten: *Dentaria pentaphylla*, *D. polyphylla*, *D. trifolia*, *Lamium orvala*, *Scopolia carniolica*.

Trennarten: *Melampyrum velebiticum*, *Pseudofumaria alba*.

Dieser Unterverband vereinigt Assoziationen mesophiler Buchenwälder im Mittelgebirge (600-1200 m Seehöhe) des illyrischen Raumes. Gerade hier besitzt die Buche ihr Lebensoptimum in dem besprochenen Gebiet. Die Tanne gehört oft zu den Kodominanten dieser Wälder.

***Lamio orvalae-Fagetum* (I. Horvat 1938) Borhidi 1963**

Basionym: *Fagetum silvaticae croaticum boreale montanum* I. Horvat 1938 p.p. (*corydaletosum*) (Art. 34) Syn.: *Orvalo-Fagetum* Tomažič 1954 (Art. 2b), *Dentario-Fagetum* M. Wraber 1960 (Art. 2b), *Enneaphyllo-Fagetum* Košir 1962 (Art. 31), *Lamio orvalae-Fagetum croaticum* Borhidi 1963 (Art. 34), *Lamio orvalae-Fagetum slovenicum* (Košir 1962) Borhidi 1963 (Art. 3b, 34), *Lamio orvalae-Fagetum prealpinum* Marinček 1981 (Art. 34), *Lamio orvalae-Fagetum praedinaricum* Marinček et al. 1983 (Art. 5, 34) Phantomname: "*Lamio orvalae-Fagetum* I. Horvat" sensu Bertović et Lovrić 1987.

Nomenklatorischer Typus: I. Horvat (1938: Tab. 3, Aufn. 18), Lectotypus hoc loco.

***Arunco-Fagetum* Košir 1962**

Nomenklatorischer Typus: Košir (1979: Tab. 8, Aufn. 5), Neotypus hoc loco.

***Isopyro-Fagetum* Košir 1962**

Nomenklatorischer Typus: Košir (1979: Tab. 6, Aufn. 12), Neotypus hoc loco.

***Cardamini savensi-Fagetum* Košir 1962**

Ursprüngliche Namensform: *Savensi-Fagetum* Košir 1962.

Nomenklatorischer Typus: Košir (1979: Tab. 2, Aufn. 3), Neotypus hoc loco.

***Lamiastro flavidi-Fagetum* Zukrigl ex Marinček et al. hoc loco**

Lamiastro flavidi-(Abieti)-Fagetum Zukrigl 1989 p.p. max. (Art. 5, 10).

Nomenklatorischer Typus: Zukrigl (1989, Tab. II, Aufn. 32), Holotypus hoc loco.

***Omphalodo-Fagetum* (Tregubov 1957) nom. nov. hoc loco**

Basionym: *Abieti-Fagetum dinaricum* Tregubov 1957 (Art. 34) Syn.: *Abieti-Fagetum dinaricum* Knapp 1942 (Art. 1, 34), *Calamintho grandiflorae-Abietetum* Borhidi 1963 (Art. 3b), *Calamintho gradiflorae-Abietetum dinaricum* (Tregubov 1957) Borhidi 1963 (Art. 29, 34), *Calamintho-Abieti-Fagetum* sensu Bertović et Lovrić 1987 (Art. 2b, 10, 29), *Abieti-Fagetum* var. geogr. *Omphalodes verna* Puncer in Zupančič et Puncer 1993 (Art. 36) Inkl.: *Fagetum silvaticae croaticum australe abietetosum* I. Horvat 1938 (Art. 34) Non: *Omphalodo-Fagetum* M. Wraber 1960 (Art. 2b).

Nomenklatorischer Typus: Tregubov (1957b: 32-34, Aufn. 13), Lectotypus hoc loco.

***Saxifrago rotundifoliae-Fagenion* suball. nova hoc loco**

Syn.: *Saxifrago rotundifoliae-Fagenion* Poldini in Zukrigl 1988 (Art. 8), *Saxifrago rotundifoliae-Fagenion* Poldini in Zukrigl 1989 (Art. 8).

Nomenklatorischer Typus: *Polysticho lonchitis-Fagetum* (I. Horvat 1938) Marinček in Poldini et Nardini 1993 (siehe unten), Holotypus hoc loco.

Trennarten: *Adenostyles alliariae*, *A. glabra*, *Cicerbita alpina*, *Geranium sylvaticum*, *Homogyne sylvestris*, *Luzula sylvatica* s. lat., *Polygonatum verticillatum*, *Polystichum lonchitis*, *Ranunculus platanifolius*, *Saxifraga rotundifolia*, *Scrophularia scopolii*.

Zum *Saxifrago-Fagenion* gehören altimontane bis subalpine Buchenwälder Illyriens, die durch zahlreiche Hochstauden, welche typisch für die *Mulgedio-Aconitetea*-Gesellschaften sind, geprägt werden.

***Polysticho lonchitis-Fagetum* (I. Horvat 1938) Marinček in Poldini et Nardini 1993**

Basionym: *Fagetum silvaticae croaticum australe subalpinum* I. Horvat 1938 p.p. (Art. 34) Syn.: *Fagetum subalpinum dinaricum* Tregubov 1957 (Art. 34), *Homogyne sylvestris-Fagetum* (I. Horvat 1938) Borhidi 1963 (Art. 3b), *Fagetum subalpinum prealpinum* Marinček 1980 (Art. 34), *Polysticho lonchitis-Fagetum* Marinček 1988 (Art. 2b, 5), *Polysticho lonchitis-Fagetum* Marinček in Zukrigl 1988 (Art. 2b, 5), *Saxifrago-Fagetum* Zukrigl 1989 p.p. (Art. 5) Inkl.: *Dentario pentyphylli-Fagetum luzuletosum* H. Mayer et A. Hofmann 1968 Phantomname: "*Homogyne alpinae-Fagetum* (I. Horvat 1938) Borhidi 1963" sensu Bertović et Lovrić 1987 Non: *Polysticho aculeati-Fagetum* Feoli et Lagonegro 1982 (Art. 5).

Nomenklatorischer Typus: I. Horvat (1938: Tab. 4, Aufn. 26), Lectotypus hoc loco.

***Anemono trifoliae-Fagetum* Tregubov 1962**

Syn.: *Fagetum subcarinthiacum* Knapp 1944 (Art. 1, 34), *Fagetum julicum* Tregubov 1951 (Art. 1, 34), *Fageto-Piceetum* M. Wraber 1956 (Art. 2b), *Anemono trifoliae-Fagetum* Tregubov 1957 (Art. 2b), *Anemono trifoliae-Fagetum subcarinthiacum* Borhidi 1963 (Art. 34), *Anemono trifoliae-Fagetum austroalpinum* Borhidi 1963 (Art. 34), *Salvio glutinosae-(Abieti)-Fagetum* Zukrigl 1988 (Art. 2b, 5, 10), *Anemono-(Abieti)-Fagetum* (Tregubov 1957) Zukrigl 1989 (Art. 10, 29), *Anemono trifoliae-Fagetum* Marinček, Poldini et Zupančič 1989 (Art. 5).

Pseudonyma: *Abieti-Fagetum* sensu Pignatti 1966 (Art. 36), *Adenostylo glabrae-Abieti-Fagetum* sensu Hartl 1975 (Art. 10), *Abieto-Fagetum* sensu Franz 1981 (Art. 36) Non: *Helleboro nigrae-(Abieti)-Fagetum* Zukrigl 1973 (Art. 10), *Aposerido-Fagetum* Oberd. 1957.

Nomenklatorischer Typus: Marinček, Poldini & Zupančič (1989: Tab. 1, Aufn. 23), Neotypus hoc loco.

***Stellario glochidispermae-Fagetum* (Zupančič 1969) nom. nov. hoc loco**

Basionym: *Aceri-Fagetum dinaricum* Zupančič 1969 (Art. 34) Pseudonym: *Aceri-Fagetum* sensu M. Wraber 1960 Non: *Aceri pseudoplatani-Fagetum* Bartsch et Bartsch 1940.

Nomenklatorischer Typus (Neotypus hoc loco): Slowenien, Trnovski gozd, 1220 m Seehöhe, Exposition S-SW, Neigung 20-25°, Deckungsgrad E3: 100%, E2: <1%, E1: 60%, EO: 15%; Datum: 15. Juni 1957, M. Wraber:

E3: *Fagus sylvatica* 4.1, *Acer pseudoplatanus* 3.1, *Picea abies* 1.1

E2: *Fagus sylvatica* +, *Acer pseudoplatanus* +, *Rubus idaeus* +, *Sorbus aucuparia* +

E1: *Galium odoratum* 3.3, *Dentaria enneaphyllos* 2.2, *Dryopteris filix-mas* 2.2, *Festuca altissima* 2.2, *Lamiasium flavidum* 2.2, *Acer pseudoplatanus* juv. 1.1, *Adoxa moschatellina* 1.2, *Cardamine trifolia* 1.2, *Corydalis cava* 1.2, *Dentaria bulbifera* 1.2, *Geranium robertianum* 1.2, *Lamium orvala* 1.3, *Lunaria rediviva* 1.2, *Oxalis acetosella* 1.2, *Stellaria glochidisperma* 1.2, *Urtica dioica* 1.2, *Adenostyles alliariae* (+.2), *Athyrium filix-femina* +.2, *Cystopteris fragilis* +.2, *Epilobium montanum* +, *Lilium martagon* +, *Milium effusum* +.2, *Mycelis muralis* +, *Myosotis sylvatica* +.2, *Paris quadrifolia* +, *Polygonatum verticillatum* +, *Polystichum aculeatum* +, *Prenanthes purpurea* +, *Ranunculus lanuginosus* (+), *Saxifraga rotundifolia* +, *Senecio ovatus* +, *Scrophularia nodosa* +, *Veratrum album* subsp. *album* +

EO: *Camptothecium lutescens* 2.5, *Amblystegium subtile* +.5, *Isoetecium alopeculoides* +.5.

***Ranunculo platanifolii-Fagetum* ass. nova hoc loco**

Syn.: *Fagetum silvaticae croaticum australe subalpinum* I. Horvat 1938 p.p. (Art. 34), *Saxifrago rotundifoliae-Fagetum* Zukrigl 1989 p.p. (Art. 5), *Adenostylo glabrae-Fagetum praepino-dinaricum* Tregubov 1962 (Art. 1, 34), *Adenostylo glabrae-Fagetum prealpinum* Smole 1971 (Art. 1, 34), *Fagetum altimontanum prealpinum* Marinček 1978 (Art. 1, 34), *Fagetum altimontanum praedinaricum* Marinček 1983 (Art. 2b, 34) Inkl.: *Lamiastro flavidi-(Abieti)-Fagetum* Zukrigl 1989 *stellarietosum* (Art. 5, 10).

Nomenklatorischer Typus: Dakskobler & E. Mayer (1992: Tab. 1, Auf. 10), Holotypus hoc loco.

***Dentario pentaphylli-Fagetum* H. Mayer et A. Hofmann 1969**

Syn.: *Fagetum austro-alpinum* (Aichinger 1933) Borhidi 1965 (Art. 34), *Galio odorati-(Abieti)-Fagetum* sensu Zukrigl 1988 (Art. 2b, 5, 10).

Nomenklatorischer Typus: Poldini & Nardini (1993: Tab. 3, Aufn. 21), ausgewählt von Poldini & Nardini (1993).

***Aconito paniculati-Fagetum* (Zupančič 1969) nom. novum hoc loco**

Basionym: *Aceri-Fagetum austroalpinum* Zupančič 1969 (Art. 34) Pseudonym: *Aceri-Fagetum* sensu M. Wraber 1960 Non: *Aceri pseudoplatani-Fagetum* Bartsch & Bartsch 1940.

Nomenklatorischer Typus (Neotypus hoc loco): Slowenien, Julische Alpen, Spodnja Komna, 1500 m Seehöhe, Exposition E-NE, Neigung 35-45°, Deckungsgrad E3: 70%, E2: 50%, E1: 60-70%, EO: 10%; Datum: 25. August 1960, M. Wraber:

E3: *Fagus sylvatica* 3.2, *Acer pseudoplatanus* 2.2, *Picea abies* +

E2: *Fagus sylvatica* 3.2, *Acer pseudoplatanus* 2.2, *Daphne mezereum* 1.2, *Lonicera alpigena* 1.2, *Rosa pendulina* 1.2, *Sorbus chamaemespilus* 1.2, *Ribes alpinum* +, *Salix appendiculata* +, *Sorbus aucuparia* subsp. *glabrata* +.2

E1: *Galium laevigatum* 2.2, *Lamiastrum flavidum* 2.2, *Mercurialis perennis* 2.2, *Prenanthes purpurea* 2.2, *Aconitum lycoctonum* subsp. *vulparia* 1.1, *A. paniculatum* 1.2, *Anemone nemorosa* 1.2, *Anemone trifolia* 1.1, *Aruncus dioicus* 1.2, *Athyrium filix-femina* 1.2, *Cirsium erisithales* 1.1, *Cyclamen purpurascens* 1.2, *Paris quadrifolia* 1.1, *Polygonatum verticillatum* 1.2, *Polystichum lonchitis* 1.2, *Rubus saxatilis* 1.1, *Senecio cacaliaster* 1.1, *Veratrum album* subsp. *lobelianum* 1.2, *Actaea spicata* +, *Adenostyles glabra* +, *Aposeris foetida* +, *Asplenium viride* +, *Bupthalmum salicifolium* +.2, *Calamagrostis varia* +.2, *Cicerbita alpina* +.2, *Crepis paludosa* +, *Cystopteris fragilis* +.2, *Dentaria enneaphyllos* +, *Doronicum austriacum* +.2, *Dryopteris filix-mas* +.2, *Fragaria viridis* +, *Gentiana asclepiadea* +, *Geranium*

syloaticum +, *Geum rivale* +, *Heracleum sphondylium* subsp. *elegans* +, *Laserpitium latifolium* +.2, *Lilium martagon* +, *Lonicera nigra* juv. +2, *Maianthemum bifolium* +, *Melica nutans* +.2, *Myrrhis odorata* +, *Phyteuma ovatum* +, *Ranunculus platanifolius* +, *Rumex alpestris* +, *Saxifraga rutundifolia* +, *Solidago virgaurea* +, *Stellaria nemorum* +, *Thalictrum aquilegifolium* +, *Vaccinium myrtillus* +, *Valeriana tripteris* +.2, *Viola biflora* +, *Viola reichenbachiana* r

E0 *Anomodon attenuatum* 1.4, *Ctenidium molluscum* +.4, *Orthodicranum montanum* +.4, *Tortella tortuosa* +.4.

***Homogyno sylvestris*-Fagetum** ass. nova hoc loco

Syn.: *Abieti-Fagetum austroalpinum* M. Wraber 1960 (Art. 2b, 34), *Abieti-Fagetum prealpinum* Robič 1965 (Art. 1, 34), *Luzulo-Abieti-Fagetum praealpinum* (Marinček 1977) Marinček et Dakskobler 1988 (Art. 10, 34) Non: *Homogyno sylvestris-Fagetum* (I. Horvat 1938) Borhidi 1963 (Art. 3b).

Nomenklatorischer Typus: Marinček & Dakskobler (1988: Tab. 3, Aufn. 16), Holotypus hoc loco.

Ostryo-Fagenion Borhidi 1963

Kennarten: *Acer obtusatum*, *Sesleria autumnalis*. Trennarten: *Asparagus tenuifolius*, *Cornus mas*, *Evonymus verrucosa*, *Fraxinus ornus*, *Lathyrus venetus*, *Ostrya carpinifolia*, *Peucedanum austriacum*, *Veratrum nigrum*, *Mercurialis ovata*.

Nomenklatorischer Typus: *Sesleria autumnalis-Fagetum* M. Wraber ex Borhidi 1963, Lectotypus hoc loco.

Das *Ostryo-Fagenion* vereinigt zonale paramediterrane und azonale (im breiteren Sinne) kontinentale thermophile Buchenwälder Illyriens. Die Kennarten des *Quercion pubescentis-sessiliflorae* unterscheiden diesen Unterverband deutlich.

Ostryo-Fagetum M. Wraber ex Trinajstić 1972

Syn.: *Ostryo-Fagetum* M. Wraber 1966 (Art. 2b), *Helleboro macranthi-Fagetum* Pelcer 1978 (Art. 31) Inkl.: *Dentario-Fagetum ostryetosum* M. Wraber 1960, *Carici-Fagetum* var. *Erica carnea* Mayer et Hofmann 1969 (Art. 3c).

Nomenklatorischer Typus: Trinajstić (1972: 178-179, Tab. 2, Aufn. 1), Lectotypus hoc loco.

Nomenklatorische Bemerkung: *Helleborus macranthus* ist ein Synonym zu *Helleborus niger* subsp. *niger*. Der Name *Helleboro macranthi-Fagetum* (Pelcer 1978) darf daher für diese Gesellschaft nicht als korrekte Bezeichnung benutzt werden, weil der Name *Helleboro nigri-Fagetum* (Zukrigl 1973) älter ist.

***Seslerio autumnalis-Fagetum* M. Wraber ex Borhidi 1963**

Syn.: *Seslerio autumnalis-Fagetum croaticum* (I. Horvat 1950) Borhidi 1965 (Art. 34), *Seslerio autumnalis-Fagetum* M. Wraber 1957 (Art. 1, 2b), *Seslerio autumnalis-Fagetum* M. Wraber 1960 (Art. 2b), *Seslerio autumnalis-Fagetum* (I. Horvat 1950) I. Horvat et al. 1974 (Art. 31) Syntax. Syn.: *Seslerio autumnalis-Fagetum moesiaca* (Blečić 1958) Blečić et Lakušić 1970 Inkl.: *Fagetum croaticum seslerietosum* I. Horvat 1950 (Art. 2b, 34), *Fagetum seslerietosum autumnalis* M. Wraber 1954 (Art. 2b), *Fagetum silvaticae montenegrinum seslerietosum* Blečić 1958 (Art. 34).

Nomenklatorischer Typus: Dakskobler (1991: Tab. 1, Aufn. 24), Lectotypus hoc loco.

***Erico-Fagetum* I. Horvat ex Trinajstić 1972**

Syn.: *Erico-Fagetum* I. Horvat 1962 (Art. 2b).

Nomenklatorischer Typus: Trinajstić (1972: 176-177, Aufn. 3), Lectotypus hoc loco.

***Aceri obtusati-Fagetum* Fabijanić, Fukarek et Stefanović ex Fukarek, Stefanović et Fabijanić 1967**

Syn.: *Aceri obtusati-Fagetum* Fabijanić, Fukarek et Stefanović 1963 (Art. 3b).

Nomenklatorischer Typus: Fabijanić, Fukarek & Stefanović (1963: 106-107, Tab. 6, Aufn. 3), Lectotypus hoc loco.

***Hemerocallido lilio-asphodelo-Ostryetum* Poldini 1982**

Nomenklatorischer Typus: Poldini (1982: 108-109, Tab. 10, Aufn. 4), Holotypus.

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ANALISI MORFOLOGICHE E CITOTASSONOMICHE SU ALCUNE ENTITA' DI *HELLEBORUS* L. SECT. *HELLEBORUS* NEL FRIULI-VENEZIA GIULIA (ITALIA NORDORIENTALE) E NELL'ISTRIA

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Keywords: *Helleborus odorus*, *H. istriacus*, *Ranunculaceae*, morphology, cytotaxonomy.

Abstract: MORPHOLOGIC AND CYTOTAXONOMIC INVESTIGATIONS ON SOME TAXA OF *HELLEBORUS* SECT. *HELLEBORUS* IN THE FRIULI-VENEZIA GIULIA REGION (NORTH-EASTERN ITALY) AND ISTRIA. On the basis of morphometric, histoanatomic and cytotaxonomic analyses, the populations of *Helleborus* of the Trieste Karst region (north-eastern Italy) and Istria with smaller floral diameter (4.4-4.8 cm), currently treated as *H. multifidus* subsp. *istriacus*, are here included into the *H. odorus* complex.

Introduzione

Nelle Alpi sudorientali e nei territori nordadriatici la sezione nominale del genere *Helleborus* è rappresentata da due entità distinguibili per diverso diametro fiorale, tendenze ecologiche e distribuzione: secondo Merxmüller & Podlech (1961) il tipo a diametro fiorale maggiore rientrerebbe in *H. odorus* W. et K. subsp. *laxus* (Host) Merxm. et Podl., l'altro in *H. multifidus* Vis. subsp. *istriacus* (Schiffn.) Merxm. et Podl.

Questo inquadramento però non ci pare soddisfacente perchè, malgrado le dimensioni fiorali più ridotte, gli esemplari carsico-istriani mostrano nel complesso una maggiore affinità morfologica esterna con *H. odorus*, piuttosto

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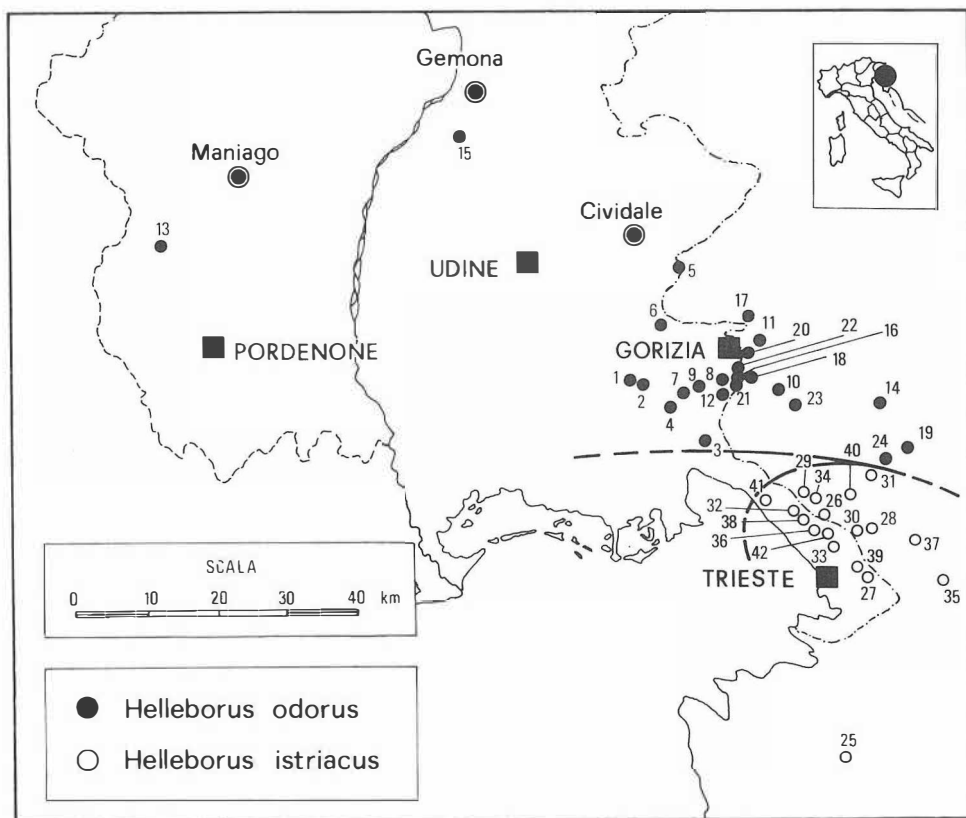


Fig.1 - Distribuzione di *Helleborus odorus* e *H. istriacus* nel Friuli orientale e nella Venezia Giulia. I numeri indicano le località di campionatura elencate in appendice.

che con *H. multifidus*, che abbiamo avuto modo di osservare e raccogliere in Dalmazia. D'altra parte, secondo l'opinione di Cristofolini e Speranza (ex verbis), nemmeno *H. odorus* risulterebbe entità autonoma, ma andrebbe ricondotto a *H. viridis*.

Da ciò lo spunto per approfondire le conoscenze su alcuni caratteri morfoanatomici e citotassonomici delle due entità considerate, al fine di poter giungere ad una più accurata definizione della variabilità specifica e dei reciproci rapporti sul piano sistematico.

In questa nota, in via del tutto provvisoria, ci limiteremo a usare i binomi *H. odorus* W. et K. per le popolazioni con diametro fiorale maggiore e *H. istriacus* Borb. per quelle a diametro più ridotto. Come si può notare nella fig. 1, nel territorio italiano i loro areali giungono a lambirsi sul Carso monfalconese, che però rappresenta una sorta di zona cuscinetto, dove entrambi risultano assenti.

Tab.1 - Classi di frequenza di *H. odorus* e *H. istriacus* in alcune fitocenosi.

Fitocenosi	<i>H. odorus</i>	<i>H. istriacus</i>
boschi		
<i>Seslerio-Quercetum petraeae</i>		4
<i>Asaro-Carpinetum betuli</i>		3
<i>Ornithogalo-Carpinetum betuli</i>	3	
<i>Ostryo-Quercetum pubescentis</i>		2
<i>Hacquetio-Fraxinetum</i>	2	
<i>Carici umbrosae-Quercetum petraeae</i>	2	
<i>Seslerio variaie-Ostryetum carpinifoliae</i>	2	
Fitocenon <i>Luzula luzuloides-Fagus</i>	2	
<i>Amelanchiero-Ostryetum carpinifoliae</i>		1
<i>Buglossoido-Ostryetum carpinifoliae</i>	1	
<i>Ostryo-Fagetum sylvaticae</i>	1	
<i>Dentario-Fagetum sylvaticae</i>	1	
siepi		
<i>Lamio orvalae-Sambucetum nigrae</i>	2	
Fitocenon <i>Galanthus-Corylus</i>	1	
orli boschivi		
<i>Cirsio pannonicum-Peucedanetum cervariae</i>		2
<i>Agropyro-Calamagrostietum epigeji</i>		1

Helleborus odorus è senza dubbio più diffuso, occupando la pianura friulana (dove, data la fortissima pressione antropica, trova spesso rifugio lungo siepi, prode di fossi e canali) e i rilievi esterni dell'arco alpino orientale; si rinviene soprattutto nei terreni profondi e freschi dei querceto-carpineti e delle faggete submontane (cfr. Marinček, Poldini & Zupančič, 1983).

Helleborus istriacus popola cenosi più termofile, sia erbacee (*Geranion sanguinei*), sia arboreo-arbustive (*Ostryo-Carpinion orientalis*, *Carpinion illyricum*) (Poldini, 1989). Maggiori dettagli di ordine fitosociologico emergono dalla tab.1, che riporta le classi di frequenza relative alle fitocenosi in cui le due entità sono state individuate finora.

Entrambe sono già state oggetto di indagini fitochimiche, che hanno portato

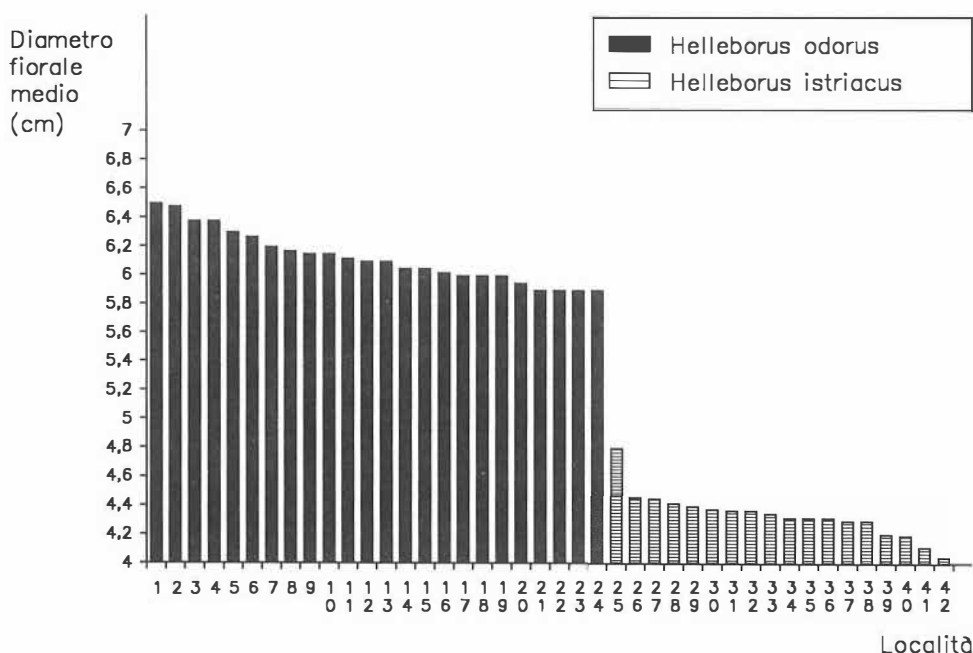


Fig.2 - Andamento dei valori medi del diametro fiorale in *H. odorus* e *H. istriacus* nelle popolazioni esaminate. I numeri in ascissa si riferiscono alle località di campionatura elencate in appendice.

all'individuazione di alcune razze chimiche (Coassini Lokar & Poldini, 1985) nonché alla definizione del tempo balsamico (Coassini Lokar, Poldini & Tubaro, 1982) e degli organi sintetizzante e di accumulo dei principi attivi (Coassini Lokar & Tomè, 1982, 1983).

In particolare le popolazioni friulane di *H. odorus* sono caratterizzate dalla presenza costante di ellebrina, desglucoellebrina e da un certo numero di saponine a struttura spirostanolica in quantità piuttosto ridotta; le popolazioni carsiche presentano invece stabilmente ellebrina, glucoellebrina e numerose saponine spirostanoliche in quantità elevata (Poldini, Coassini Lokar & Fornasaro, 1977).

I glicosidi cardiocinetici del genere *Helleborus* rientrano nella categoria dei bufadienolidi; l'ellebrina, il glicoside prevalente (0.4-0.5 %), è il glucoramnoside dell'ellebrigenina e presenta attività biologiche simili a quelle dei glicosidi strofantoidei. L'ellebrina pura rientra in alcune formulazioni farmaceutiche, sia sotto forma di tintura che in omeopatia.

Materiali e metodi

Le analisi morfometriche e istoanatomiche sono state condotte sistematica-

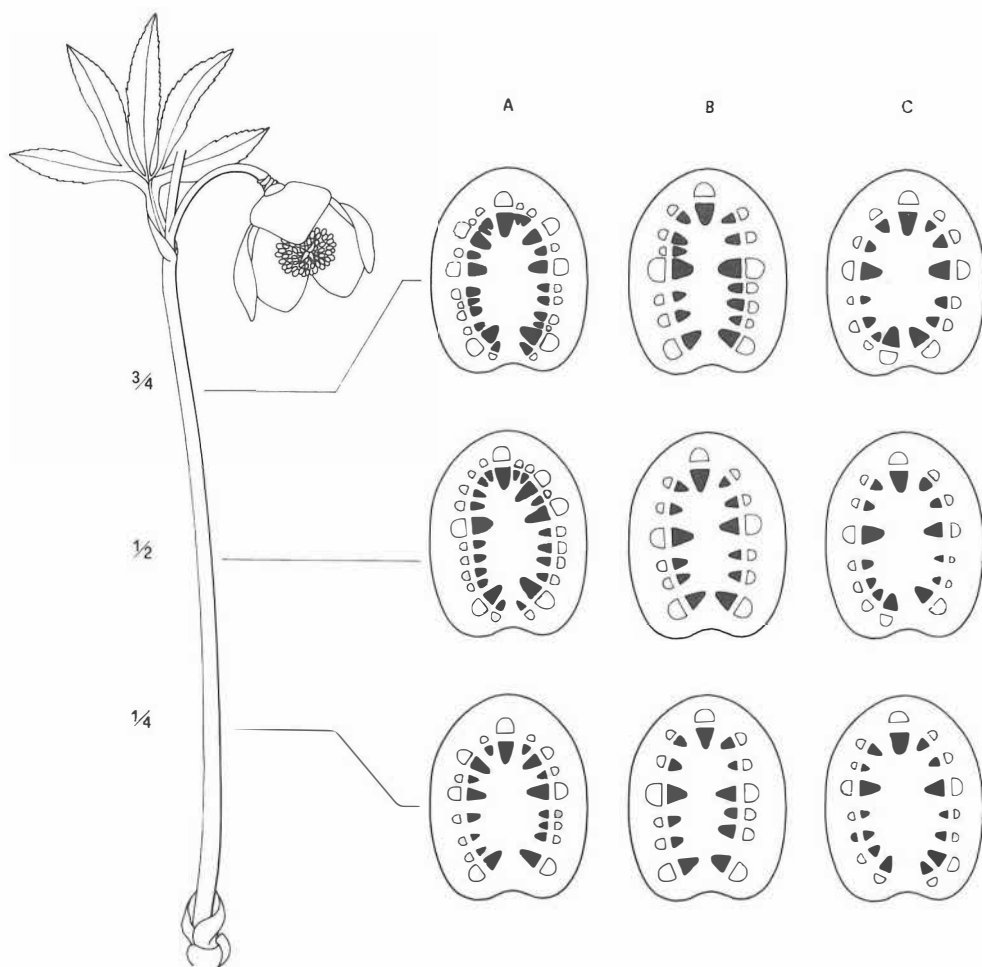


Fig.3 - Disposizione dei fasci vascolari in sezioni trasversali del caule in *H. odorus* (A) e *H. istriacus* del Carso (B) e dell'Istria (C).

mente su trenta individui di ciascuna popolazione considerata nei momenti di piena fioritura, allorchè i follicoli sono perfettamente visibili e alla completa maturazione dei follicoli stessi.

L'ubicazione delle popolazioni esaminate è indicata in appendice e in fig. 1: alle popolazioni friulane e carsiche sono state associate a titolo di confronto anche popolazioni di *H. istriacus* localizzate in Istria.

Le osservazioni dei caratteri istoanatomici sono state condotte al microscopio ottico Nikon su sezioni (10-20 μ di spessore) fissate, decolorate e trattate quindi con coloranti specifici (verde iodio, rosso Congo, rosso neutro,

Sudan III e IV, acido periodico).

Per le osservazioni al SEM, le parti da analizzare sono state fissate e immerse in glutaraldeide al 6% in tampone cacodilato 0.1 M (pH 6.9) a 0°C per una settimana, seguendo la procedura descritta da Trevisan, Cappelletti & Caniato (1983). I campioni hanno subito graduale disidratazione in acetone a concentrazioni crescenti, seccati con il metodo del punto critico (Balzers Union Critical Point Dryer) e rivestiti con oro in un Edwards S150A Sputter Coater. Le osservazioni sono state effettuate presso il Dipartimento di Biologia dell'Università di Trieste con microscopio a scansione Philips 500 ad un voltaggio di accelerazione di 12 KV.

Analisi e discussione dei risultati

Diametro florale

I risultati delle misurazioni del diametro florale, effettuate nello stadio antesico corrispondente alla fase di incipiente maturazione dei follicoli, in cui si ha il massimo sviluppo del fiore, sono riportati nell'istogramma di fig. 2.

Nelle misurazioni si è tenuto conto solo dei fiori posti inferiormente in quanto, come osservato anche da Servettaz, Colombo & Tomè (1988), quelli terminali dell'infiorescenza hanno molto spesso dimensioni minori.

In accordo con Merxmüller & Podlech (1961) il valore più elevato spetta a *H. odoratus*, il cui diametro medio misura 6 cm, mentre in *H. istriacus* oscilla fra 4.4 cm delle popolazioni carsiche e 4.8 cm di quelle istriane.

Lembo e picciolo fogliare

Lo spessore della cuticola fogliare è più rilevante nelle popolazioni carsiche di *H. istriacus*. Lo strato ceroso presenta caratteristiche striature che in quest'ultimo risultano più numerose e maggiormente spesse. Esse sono scarse e sottili nelle popolazioni istriane, mentre hanno caratteristiche intermedie in *H. odoratus*.

A ciò va aggiunto che in *H. istriacus* del Carso le cellule del tessuto a palizzata sono più lunghe e strette.

Negli esemplari di *H. istriacus* del Carso l'epidermide si presenta doppiamente stratificata ed è provvista di uno strato cuticolare più spesso, mentre negli altri appare monostratificata con strato cuticolare meno sviluppato.

Fasci vascolari caulini

Tab.2 - Numero dei fasci cribrovascolari accessori in sezioni cauline situate ad altezze diverse nelle entità considerate (valori medi approssimati all'unità).

Posizione sezioni	<i>H. odorus</i>	<i>H. istriacus</i> (Carso)	<i>H. istriacus</i> (Istria)
1/4	(10) 12 (14)	(7) 8	6 (7)
1/2	(10) 15 (19)	(7) 8 (9)	10
3/4	(15) 17 (19)	(5) 9 (12)	(6) 8 (9)

Nel sistema vascolare eustelico del caule, ai fasci cribrolegnosi principali, il cui numero (5-6) rimane mediamente costante, sono associati piccoli fasci accessori, il cui numero presenta interessanti modalità di variazione nelle popolazioni esaminate.

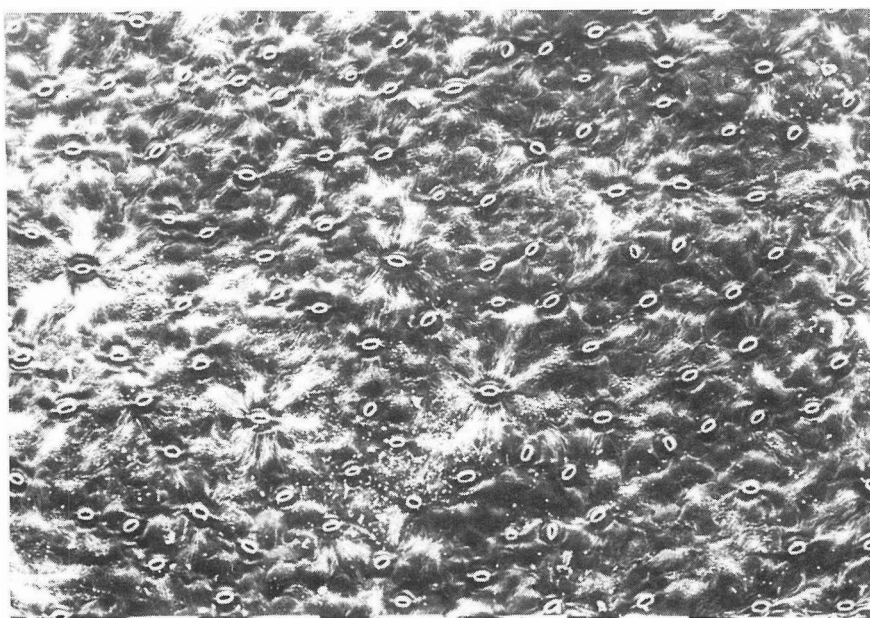
In sezioni trasversali, operate rispettivamente a 1/4, 1/2 e 3/4 dell'altezza del caule, si nota che il numero dei fasci accessori per ciascuna sezione è nettamente maggiore nelle popolazioni di *H. odorus* (tab. 2). Inoltre, sia in queste che nelle popolazioni carsiche di *H. istriacus*, il numero di tali fasci aumenta verso la sommità del caule stesso.

Anche il numero totale dei fasci (tab. 3) segue tale andamento: *H. odorus* presenta mediamente 21 fasci rispetto ai 14 delle popolazioni di *H. istriacus* (fig. 3).

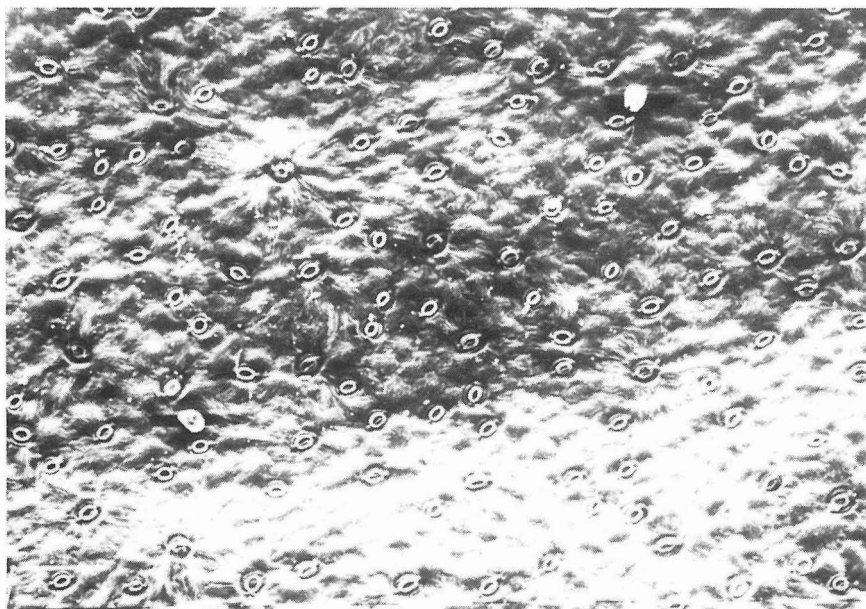
In *H. odorus* inoltre, ogni fascio cribrovascolare risulta contraddistinto da un triplo strato di fibre (floema interno) che circonda lo xilema nella parte

Tab.3 - Numero complessivo dei fasci cribrovascolari in sezioni cauline situate ad altezze diverse nelle entità considerate (valori medi approssimati all'unità).

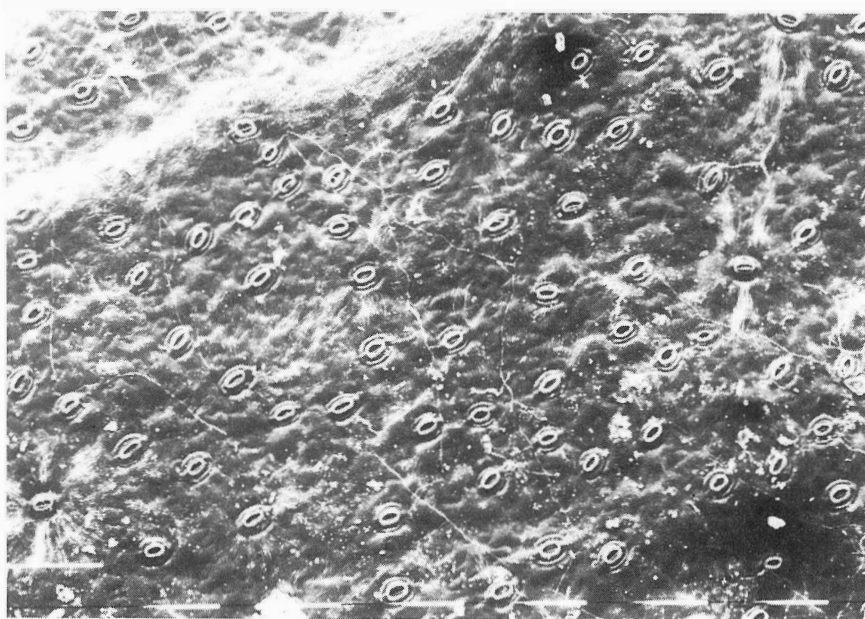
Posizione sezioni	<i>H. odorus</i>	<i>H. istriacus</i> (Carso)	<i>H. istriacus</i> (Istria)
1/4	(17) 18 (20)	(12) 13	(14) 15 (16)
1/2	(18) 22 (25)	(12) 13 (14)	14
3/4	(21) 23 (25)	(12) 15 (17)	(13) 14



A)



B)



C)

Fig.4 - Densità degli stomi in foglie di *H. odorus* (A) e *H. istriacus* del Carso (B) e dell'Istria (C) ($\times 80$; — = 100 μ).

inferiore; tale formazione, che nelle popolazioni carsiche di *H. istriacus* si presenta ancora mono o bistratificata, non compare negli esemplari istriani.

Stomi

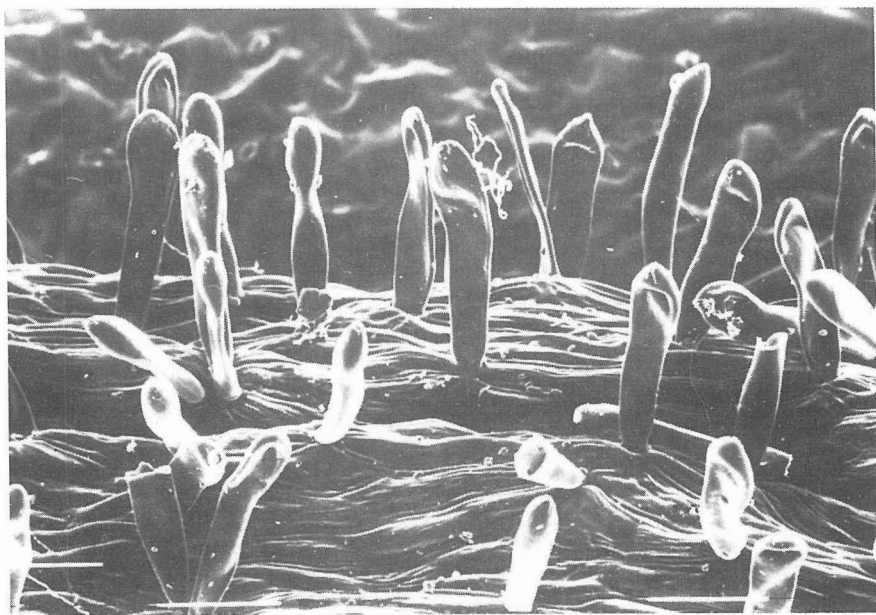
Le foglie delle entità considerate appaiono ipostomatiche e gli stomi, secondo la definizione data da Metcalfe & Chalk (1950), appartengono al tipo onomatocitico, essendo circondati da cellule epidermiche isomorfe, irregolarmente disposte intorno alle cellule di guardia.

Mentre la forma degli stomi è la medesima, le dimensioni medie variano alquanto, così come il numero di stomi per unità di superficie: in *H. odorus* gli stomi sono più piccoli ma diffusi; nelle popolazioni carsiche di *H. istriacus* essi sono maggiori e presentano densità media di poco superiore; nelle popolazioni istriane infine hanno dimensioni massime e densità minima (tab. 4 e fig. 4).

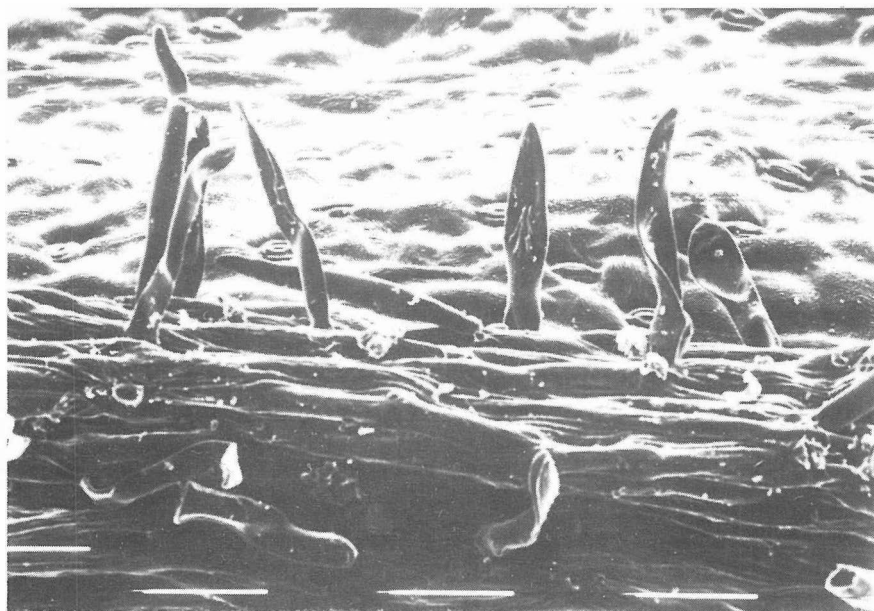
Tricomi

In tutti gli esemplari si sono osservati tricomi su entrambe le pagine fogliari, specialmente lungo le nervature.

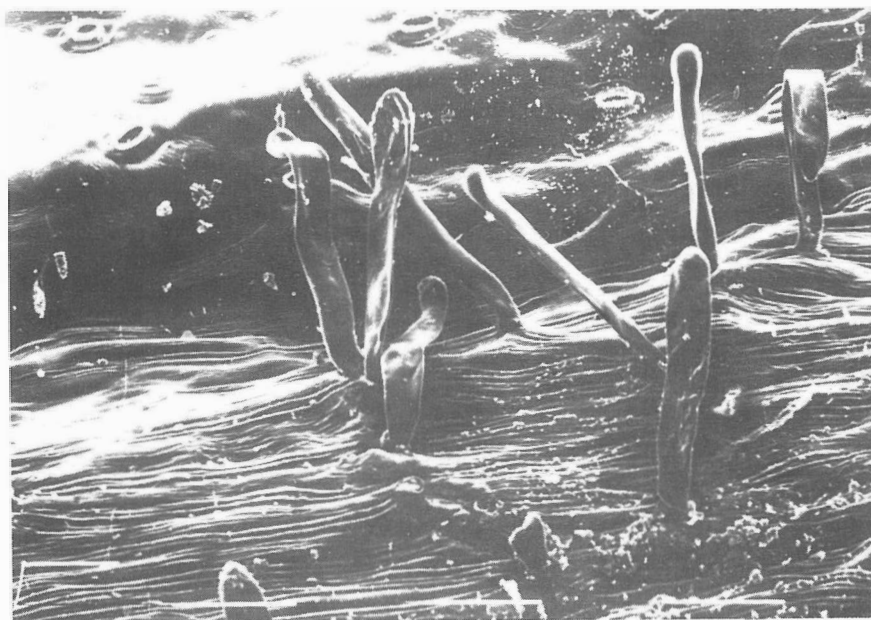
La densità di tali tricomi, minore in *H. odorus* (fig. 5), aumenta sensibilmente



A)



B)



C)

Fig.5 - Tipi di tricomi osservati in *H. odoratus* (A) e *H. isiriacus* del Carso (B) e dell'Istria (C) ($\times 160$; — = 100 μ).

nelle popolazioni carsiche di *H. istriacus* ed è massima negli esemplari istriani.

Nella definizione dei tipi di tricomi osservati ci atterremo alla classificazione di Martinis (1974), in base alla quale *H. odoratus* risulta contraddistinto da frequenti tricomi utriculiformi a utricolo piccolo, meno frequenti tricomi claviformi e piriformi, rari tricomi utriculiformi tipici.

H. istriacus del Carso triestino presenta più spesso tricomi utriculiformi tipici, meno frequentemente tricomi utriculiformi a canna, raramente tricomi bacilliformi a ingrossamento intermedio.

Tab.4 - Dimensioni medie (μ) e densità media (10^3 stomi/cm²) degli stomi nelle popolazioni considerate.

Stomi	<i>H. odoratus</i>	<i>H. istriacus</i> (Carso)	<i>H. istriacus</i> (Istria)
dimensioni	26.3 x 17	30.3 x 23.7	36.3 x 24.3
densità	(84) 117 (143)	(103) 128 (149)	(70) 84 (92)



Fig.6 - Piastra metafasica di *Helleborus istriacus* del Carso (M. Lanaro) ($2n = 32 + 3B$). Le frecce indicano tre coppie di cromosomi B.

Infine le popolazioni istriane mostrano più spesso tricomi bacilliformi tipici, meno frequenti tricomi utriculiformi a canna, raramente tricomi utriculiformi tipici.

Numero cromosomico

Per *H. odorus* è da tempo noto $2n = 32$ (Langlet, 1932); di recente Martinis & Lovasen-Eberhardt (1973) hanno stabilito $2n = 30 + (1-11 B)$ per *H. multifidus* s.l. e $2n = 30 + (1-9 B)$ per la sottospecie nominale; in *H. multifidus* subsp. *intermedius* si sono contati invece $2n = 20 + (1-4 B)$ e $2n = 30 + (1-3 B)$. Particolare significato assume quindi in *H. multifidus* la presenza di cromosomi accessori (fino a 11) in numero variabile nelle diverse sottospecie.

Le piastre metafasiche da esemplari di *H. istriacus* del Carso (M. Lanaro) sono illustrate in fig. 6. Il cariotipo prevalente è $2n = 32 + 3B$, tuttavia si è notata anche la presenza di un solo cromosoma accessorio.

Le popolazioni carsiche possiedono quindi numero cromosomico $2n = 32 + (1-3B)$, il che le ricollega al ciclo di *H. odorus*. L'esistenza di cromosomi accessori, tipica invece di *H. multifidus* s.l., può essere attribuita in prima istanza, in attesa di ulteriori indagini, a fenomeni adattativi alle caratteristiche ecologiche del Carso, improntate a condizioni climatiche più marcatamente submediterranee e a un'aridità pronunciata, tipica dei substrati calcarei.

Conclusioni

Il complesso dei caratteri analizzato permette di formulare alcune significative considerazioni.

Le popolazioni carsiche, finora attribuite in base al diametro florale a *H. multifidus* subsp. *istriacus* ($2n = 20, 30$), presentano un corredo cromosomico $2n = 32$, che è proprio di *H. odorus*.

Ai cromosomi B, presenti seppure in numero minore rispetto a *H. multifidus* s.l. (cfr. Martinis & Lovasen-Eberhardt, 1973), può venire attribuito un significato metabolico-adattativo in rapporto a una maggiore modulazione ecologica (Moss, 1966; Corsi & Garbari, 1971).

Ciò troverebbe peraltro conferma in alcuni caratteri, sia delle popolazioni carsiche che di quelle istriane, improntati ad adattamento xero-termofilo: ne sono altrettanti esempi l'aumento di densità dei tricomi, di spessore dell'epidermide e della cutina e probabilmente anche la riduzione del numero dei fasci conduttori accessori.

In base alle considerazioni esposte riteniamo quindi giustificato ricondurre al ciclo di *H. odorus* le popolazioni carsiche, inquadrandole solo provvisoriamente in *H. istriacus*: siamo infatti dell'opinione che le caratteristiche morfo-anatomiche, citotassonomiche e corologiche non risultino consistenti al punto da giustificare l'autonomia specifica, come sostenuto da Borbás (1892) e Lacza (1958), tuttavia siano meglio definite di quelle di semplice varietà, come proposto da Schiffner (1889) e che pertanto la posizione sistematica raccomandabile sarebbe quella sottospecifica, subordinata a *H. odorus* o a *H. viridis* qualora venisse confermata l'identità dei due binomi.

Appendice. Ubicazione delle popolazioni esaminate.

1. Medea; 2. Borgnano; 3. Pietrarossa; 4. Sagrado; 5. M. Corada; 6. M. Quarin; 7. Poggio Terza Armata; 8. Castel Rubbia; 9. M. S. Michele; 10. Boccavizza (SLO); 11. Bosco Panovec (SLO); 12. S. Martino del Carso; 13. Pra' di Plans (M. Cavallo di Pordenone); 14. Sable (SLO); 15. M. di Buia; 16. Rupa; 17. Salcano; 18. Bilje/Biglia (SLO); 19. Mance (SLO); 20. Sv. Peter pri Gorici/S. Pietro di Gorizia (SLO); 21. Peteano; 22. Peci; 23. M. Ermada; 24. Štjak/S. Giacomo in Colle (SLO); 25. Ceppi di Portole/Čepić (CRO); 26. M. Lanaro; 27. Padriciano; 28. Sežana (SLO); 29. Veliki Dol/Vallegrande (SLO); 30. Ferneti; 31. Dobravljje/Dobraule (SLO); 32. Sales; 33. Opicina; 34. Krajna Vas/Villa Cargna (SLO); Matavun/Mattauno (SLO); 36. Borgo Grotta Gigante; 37. Poverio/Povir (SLO); 38. Sgonico; 39. Trebiciano; 40. Dutovlje/Duttogliano (SLO); 41. S. Croce; 42. Rupinpiccolo.

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CARIOLOGIA DI TAXA CRITICI SU SUOLI CALAMINARI (CAVE DEL PREDIL, ALPI GIULIE, ITALIA)

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Keywords: calamine soils, chromosome numbers, karyotype simmetry, idiograms, metallophytes, Mine of Raibl.

Abstract: KARYOLOGY OF SOME CRITICAL TAXA ON CALAMINE SOILS (CAVE DEL PREDIL, JULIAN ALPS, ITALY). The results of chromosome counts and analyses of karyotype asymmetry on polymorphic taxa growing on calcareous and metalliferous soils and on tailings of a zinc and lead mine are reported. The investigated taxa are: *Biscutella laevigata* L. subsp. *laevigata* ($2n=36$); *Dianthus sylvestris* Wulf. ($2n=30$); *Erysimum sylvestre* (Cr.) Scop. ($2n=14$); *Minuartia verna* (L.) Hiern. ($2n=24$); *Viola tricolor* L. subsp. *subalpina* Gaudin ($2n=26$) and its var. *raiblensis* Lausi et Cusma ($2n=26$) of the same subspecies; *Alyssum wulfenianum* Bernh. ($2n=16$); *Thlaspi cepaeifolium* (Wulf.) Koch subsp. *cepaefolium* ($2n=14$). New chromosome numbers are reported for *Alyssum wulfenianum* and for *Thlaspi cepaeifolium* in its *locus classicus*.

Introduzione

La flora calaminare centroeuropea e alpina è caratterizzata da stirpi critiche di delimitazione e collocazione tassonomica molto controverse. Difatti, i taxa individuati presentano caratteri morfologici scarsamente discriminanti e, in letteratura, diversamente interpretati. Alcuni di questi taxa sono esclusivi dei terreni ricchi in metalli pesanti, altri invece, di più ampia valenza ecologica, partecipano a tale flora con ecotipi differenziabili morfologicamente oppure solo cariologicamente (razze cromosomiche). Inoltre, la definizione tassonomica è resa ancora più problematica dal fatto che molte popolazioni di questi taxa presentano forme di crescita stentata ed anomala e particolari fitomorfosi: riduzione del lembo fogliare, colorazione antocianica e, in caso di eccessivo assorbimento di metalli pesanti, clorosi (Ernst, 1965, 1972; Aichinger, 1971; Melzer, 1973; Simon, 1978; Rose et al., 1979; Sasse, 1979; Vergnano Gambi et al., 1979; Maier et al., 1981).

Lo scopo di questo lavoro è quello di chiarire dal punto di vista cariologico i problemi tassonomici succitati per alcuni taxa. Tale lavoro è inserito nelle ricerche vegetazionali ed ecofisiologiche in corso nella stessa area di studio.

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Materiali e metodi

L'area di studio è situata alla sinistra idrografica di Rio del Lago, sulle pendici calcaree e metallifere del Monte Re esposte a SE, ad un'altitudine variabile tra 850 e 1400 m.

Le entità analizzate sono le seguenti: *Alyssum wulfenianum* Bernh., *Biscutella laevigata* L. subsp. *laevigata*, *Dianthus sylvestris* Wulf., *Erysimum sylvestre* (Cr.) Scop., *Minuartia verna* (L.) Hiern., *Thlaspi cepaeifolium* (Wulf.) Koch subsp. *cepaefolium*, *Viola tricolor* L. subsp. *subalpina* Gaudin, *Viola tricolor* L. subsp. *subalpina* Gaudin var. *raiblensis* Lausi et Cusma. Gli essecati dei taxa indagati sono depositati nell'Erbario dell'Università di Trieste (TSB).

Le osservazioni kariologiche sono state eseguite su metafasi di cellule meristematiche di apici radicali ottenuti dalla germinazione di semi. Gli apici sono stati colorati con la reazione Feulgen, dopo pretrattamento con 8-idrossichinolina 0,003 M, e quindi schiacciati. L'analisi kariologica è stata effettuata su non meno di venti meristemi apicali per ogni entità. La nomenclatura impiegata per la morfologia dei cromosomi segue White (1973) e le formule cromosomiche sono in accordo con Levan et al. (1964).

È stato inoltre calcolato il valore dell'asimmetria dei corredi cromosomici secondo il metodo di Stebbins (1971), basato su categorie di cariotipi asimmetrici, e quello di Romero Zarco (1986), che permette di quantificare e rappresentare graficamente anche piccole differenze di asimmetria nei diversi cariotipi mediante due indici: A_1 = indice intracromosomale di asimmetria (asimmetria del cariotipo in relazione al rapporto medio tra la lunghezza dei bracci) e A_2 = indice intercromosomale di asimmetria (coefficiente di dispersione di Pearson della lunghezza dei cromosomi).

Risultati e discussione

I dati ottenuti in base alle osservazioni sui corredi cromosomici dei diversi taxa (Fig 1 e 2) sono sintetizzati in Tab. 1. Inoltre, la Tab. 1 riporta i dati dell'analisi kariologica di *Viola tricolor* subsp. *subalpina* var. *raiblensis* individuata nell'area mineraria di Cave del Predil (Lausi & Cusma, 1986) e, per confronto, quelli rilevati su popolazioni del taxon tipico corrispondente di suoli non metalliferi delle Alpi Carniche (Sauris di Sotto, Ampezzo, Udine) (Fig. 3). In questo lavoro viene discussa l'analisi dell'asimmetria dei loro cariotipi.

Tab. 1

T A X O N	2n	Formula cromosomica	C [μm]	δ [μm]	A ₁	A ₂	AS
<i>Alyssum wulfenianum</i>	16	10m + 6sm	1.71 ± 0.28	0.75	0.37	0.16	3A
<i>Biscutella laevigata</i> subsp. <i>laevigata</i>	36	4M + 20m + 12sm	1.58 ± 0.40	1.45	0.31	0.25	3B
<i>Erysimum sylvestre</i>	14	2M + 8m + 4sm	1.31 ± 0.29	0.86	0.31	0.22	[3A]3B
<i>Minuartia verna</i>	24	18m + 6sm	1.55 ± 0.26	0.80	0.36	0.17	3A
<i>Thlaspi cepaeifolium</i>	14	4M + 10m	1.55 ± 0.44	1.15	0.19	0.28	4B
<i>Viola tricolor</i> subsp. <i>subalpina</i>	26	4M + 14m + 8sm	1.90 ± 0.46	1.60	0.30	0.24	3B
<i>Viola tricolor</i> subsp. <i>subalpina</i> var. <i>raiblensis</i>	26	4M + 8m + 10sm + 4st	2.89 ± 0.68	2.30	0.40	0.24	2B

2n = numero cromosomico somatico

C = lunghezza dei cromosomi (valore medio $\pm$ s.d.)

δ = ambito di variazione della lunghezza dei cromosomi

A₁ = indice intracromosomale di asimmetria (Romero Zarco, 1986)

A₂ = indice intercromosomale di asimmetria (" " ")

AS = categorie di Stebbins (1971) dell'asimmetria del cariotipo

Analisi cariologica

Alyssum wulfenianum (Fig 1a)

Numero cromosomico: 2n=16

Exsiccatum: Greto del Rio del Lago (Cave del Predil, UD), 900 m, lg. T. Cusma Velari, 26.6.1981.

Il numero cromosomico base del genere *Alyssum* è probabilmente $x = 8$ (Manton, 1932; Contandriopoulos e Afzal-Rafii, 1973). Manton (op. cit.) riporta per *A. wulfenianum* $2n = 32$, rilevato su piante in coltura nell'Orto Botanico di Gotheburg; Gadella e Kliphuis (1970) riportano $2n = 32$ per campioni provenienti dalle Alpi Francesi. Persson (1971) ha rilevato costantemente $2n = 16$ in diversi taxa di *Alyssum* appartenenti alla sect. *Alyssum*, su materiale

proveniente dalla Macedonia. Secondo tale autore, questa sezione, che include *A. wulfenianum*, sarebbe caratterizzata dal fatto di avere *rod-shaped-chromosomes*.

Il cariotipo, rilevato per la prima volta, è costituito da 5 coppie di cromosomi metacentrici e 3 coppie di cromosomi submetacentrici (Fig. 1a). La lunghezza dei cromosomi varia da 1,25 a 2 μm . La formula cromosomica è la seguente: $2n = 2x = 16: 10\text{m} + 6\text{sm}$.

***Biscutella laevigata* subsp. *laevigata* (Fig. 1b)**

Numero cromosomico: $2n=36$

Exsiccatum: Cave del Predil (UD), 1080 m, lg. T. Cusma Velari, 30.8.1981.

Biscutella laevigata L. *sensu* Guinea & Heywood (1993) comprende numerosi taxa a livello infraspecifico scarsamente differenziati morfologicamente e costituisce uno dei complessi più polimorfici e tassonomicamente più critici della flora europea. Secondo Manton (1932, 1934, 1937) questo complesso di forme risulta costituito da una serie di razze cromosomiche con diversi gradi di ploidia difficilmente differenziabili morfologicamente, ciascuna delle quali però tendenzialmente distinguibile dal punto di vista corologico. *B. laevigata* è uno degli esempi più citati della capacità di una specie di colonizzare mediante poliploidizzazione nuovi habitat caratterizzati da condizioni ecologiche estreme (Stebbins, 1960).

Si ritiene che il numero cromosomico base sia $x = 9$ (Olowokudejo & Heywood, 1984).

Allo stato attuale delle conoscenze, la distribuzione corologica delle diverse popolazioni in base al grado di ploidia è la seguente:

popolazioni esaploidi ($6x = 54$) localizzate in Spagna e Portogallo (Manton, 1937; Olowokudejo & Heywood, 1984);

popolazioni tetraploidi ($4x = 36$) di altitudini elevate, con una distribuzione più o meno continua nelle Alpi Centrali svizzere ed austriache, nelle montagne meridionali e sudorientali d'Europa e nell'Italia settentrionale (Manton, op. cit.). Secondo Schönfelder (1968, 1970) il gruppo tetraploide sembra avere il suo centro di diffusione nell'area alpina: questo autore riporta $n = 18$ per campioni della Ötztal (Tirolo) e del Monte Baldo (Lago di Garda); Gadella & Kliphuis (1970) hanno rilevato $2n = 36$ su esemplari delle Alpi Francesi; Olowokudejo & Heywood (1984) riportano per il 90% degli esemplari esaminati provenienti da Francia, Svizzera ed Austria $2n = 36$;

popolazioni diploidi ($2x = 18$) prevalentemente di pianura con distribuzione molto più ristretta e discontinua rispetto a quelle tetraploidi. Queste popolazioni sono distribuite dalla Francia, Germania, Belgio ai Balcani, in aree che non sono state interessate dalle glaciazioni. Lawalrée (1956) riporta il numero aploide $n = 9$ per materiale raccolto in Belgio; Schönfelder (1968) ha rilevato $n = 9$ su piante raccolte nella Baviera settentrionale e nei pascoli montani della Francia

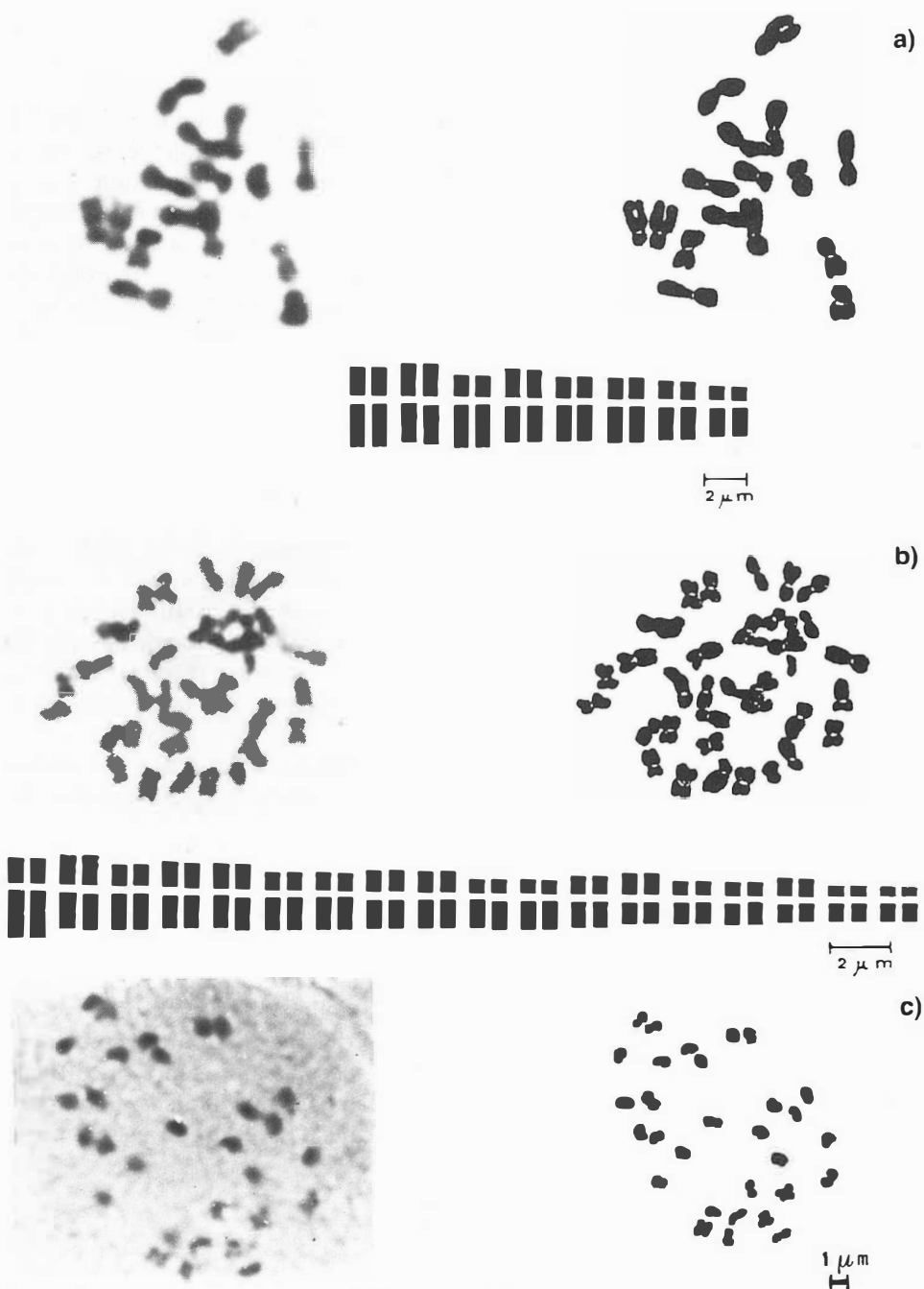


Fig. 1 - Cariotipo ed idiogramma di: a) *Alyssum wulfenianum*; b) *Biscutella laevigata* subsp. *laevigata*; c) cariotipo di *Dianthus sylvestris*.

meridionale; Larsen (1956) riporta pure $2n = 18$ determinato su esemplari dell'Italia meridionale.

Secondo altri autori, le differenze corologiche fra stirpi diploidi e tetraploidi non sarebbero però così marcate. Popolazioni diploidi sono state segnalate da Favarger (1962) nelle Alpi Marittime. Lausi, in base a ricerche non ancora pubblicate, ha rilevato popolazioni diploidi nelle Alpi Giulie (Passo degli Scalini e Gruppo del M. Jof Fuart) e sul Carso Sloveno (Valle di Brestovica), mentre sul Carso Triestino (Val Rosandra), ha riscontrato la presenza di popolazioni diploidi, esclusive dei macereti, in contatto con popolazioni tri- e tetraploidi. La diploide *B. laevigata* var. *mollis* Schur. sembra inoltre confinata a poche vette nelle Alpi Orientali e forse in Romania (Manton, 1937); Bresinsky & Grau (1970) segnalano sia diploidi che tetraploidi nell'avanterra delle Alpi Bavaresi.

Recentemente Olowokudejo & Heywood (1984), in base ad un'ampia analisi svolta su 46 popolazioni di *Biscutella* provenienti da Spagna, Svizzera, Austria, Francia, Cecoslovacchia e Italia, propongono di considerare le stirpi dell'aggregato *B. laevigata* come appartenenti ad una singola specie, cui afferiscono una serie di sottospecie più o meno differenziate, alcune delle quali sono diploidi ($2n = 18$) e altre tetraploidi ($2n = 36$). Questa specie è l'unica, nell'ambito del genere, a mostrare poliploidia intraspecifica. Difatti, dal punto di vista morfologico, esiste un passaggio graduale con sovrapposizione di caratteri dei diploidi e dei tetraploidi, ed ogni separazione tassonomica proposta è quindi da considerare arbitraria. Gli stessi autori sottolineano che la possibilità di identificazioni errate è molto alta.

Dal punto di vista carilogico, la popolazione di Cave del Predil è tetraploide con numero cromosomico $2n = 36$. Il cariotipo presenta 12 coppie di cromosomi metacentrici, di cui 2 in senso stretto, e 6 coppie di cromosomi submetacentrici (Fig. 1b). La lunghezza dei cromosomi varia da 0,95 a 2,40 μm . La formula cromosomica è: $2n = 4x = 36: 4M + 20m + 12sm$. I cromosomi sono in prevalenza metacentrici di tipo m.

I caratteri morfologici, che secondo le osservazioni di Bresinsky & Grau (1970) sono i più diacritici per l'identificazione del grado di plodia delle diverse stirpi di *Biscutella*, non risultano validi nel caso delle popolazioni di Cave del Predil. Difatti, in queste popolazioni, alcuni di questi caratteri mostrano un'ampia variabilità. Per questo motivo tali popolazioni sono di difficile collocazione tassonomica a livello infraspecifico su base morfologica. Per il dato carilogico rilevato, la popolazione tetraploide di Cave del Predil è stata per il momento attribuita alla sottospecie tipica.

Dianthus sylvestris (Fig. 1c)

Numero cromosomico: $2n=30$

Exsiccatum: Cave del Predil (UD), 1300 m, lg. T. Cusma Velari, 14.10.1981.

D. sylvestris è una specie ad ampia distribuzione centro-sudeuropea con una notevole variabilità morfologica, non ancora chiarita dal punto di vista tassonomico (Pignatti, 1982).

Il numero cromosomico di questa specie risulta $2n = 30$ ($x = 15$) da osservazioni su popolazioni provenienti da diverse zone del suo ampio areale (Ishii, 1930; Anderson-Kottö & Gairdner, 1931; Rohweder, 1934, 1937, Gentscheff, 1937; Ribaupierre, 1957; Arrigoni & Mori, 1971; Nilsson & Lassen, 1971; Raimondo & al., 1983). Jones & Hooper (1968) riportano invece $2n = 60$ ca. per popolazioni delle Alpi Marittime francesi.

Le popolazioni di Cave del Predil presentano alcuni caratteri morfologici particolari, il cui significato tassonomico necessita di ulteriori indagini. Il corredo cromosomico risulta essere $2n = 30$ con cromosomi molto piccoli (da 0,72 a 1,20 μm) e per lo più metacentrici (Fig. 1c). Per le ridotte dimensioni dei cromosomi non è stato possibile identificare la morfologia del cariotipo.

Erysimum sylvestre (Fig. 2a)

Numero cromosomico: $2n=14$

Exsiccatum: Cave del Predil (UD), 1060 m, lg. T. Cusma Velari, 30.8.1981.

E. sylvestre è una pianta che spesso colonizza accumuli detritici calaminari (Ernst, 1965; Maier & al., 1981). È specie illirica distribuita dall'Albania fino alle Alpi sudorientali.

Il genere *Erysimum* è ancora poco studiato dal punto di vista cariologico. Inoltre è stata rilevata una notevole difficoltà ad ottenere ottime fissazioni e colorazioni del materiale in quanto i cromosomi tendono spesso ad aderire fra loro (Manton, 1932; Favarger, 1964). I numeri cromosomici base del genere sono probabilmente $x = 7, 8, 9$ (Manton, 1932; Favarger, 1964; Polatschek, 1966). Per *E. sylvestre* Jaretzky (1928) riporta $n = 24$ per materiale in coltura nel Giardino Botanico di Kiel; Favarger (1964) e Polatschek (1966) riportano $2n = 14$ per popolazioni di diverse stazioni dell'Austria.

Il numero cromosomico degli esemplari di Cave del Predil risulta essere $2n = 14$. Nonostante le difficoltà suesposte, dopo numerose prove, è stato possibile individuare il seguente cariotipo: 5 coppie di cromosomi metacentrici, di cui 2 in senso stretto, e 2 coppie di cromosomi submetacentrici (Fig. 2a). La lunghezza dei cromosomi varia da 0,86 a 1,72 μm . La formula cromosomica è la seguente: $2n = 2x = 14: 2M + 8m + 4sm$.

Minuartia verna (Fig. 2b)

Numero cromosomico: $2n=24$.

Exsiccatum: Cave del Predil (UD), 1180 m, lg. T. Cusma Velari, 14.10.1981.

L'aggregato di *M. verna* comprende entità molto diverse morfologicamente e cariologicamente. Dalle conoscenze attuali, i numeri cromosomici di questo gruppo presentano due livelli di ploidia con $x = 12$: uno diploide $2n = 24$ ed uno

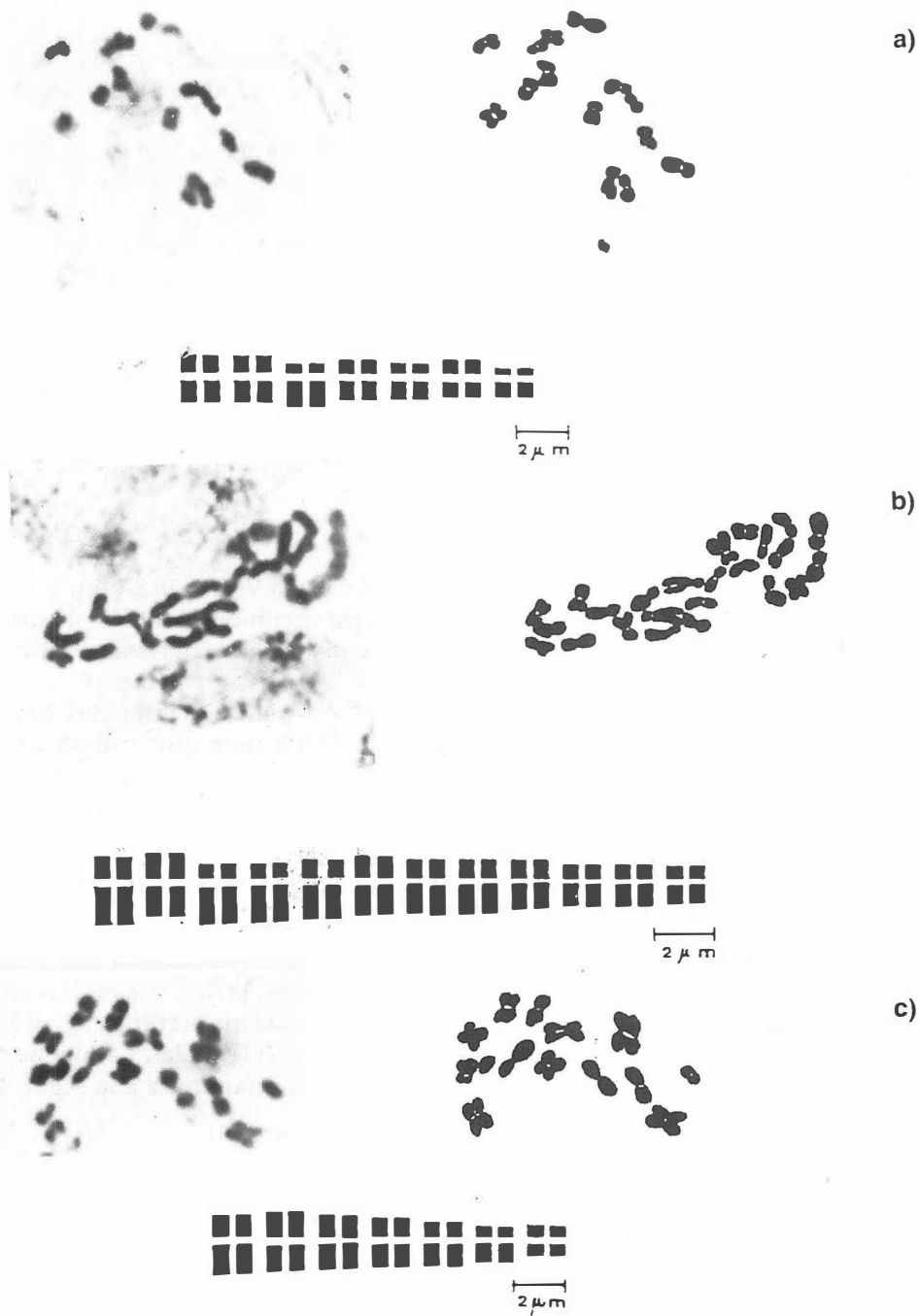


Fig. 2 - Cariotipo ed idiogramma di: a) *Erysimum sylvestre*; b) *Minuartia verna*; c) *Thlaspi cepaeifolium*.

tetraploide $2n = 48$ (Favarger, 1967). Dvořáková (1985) rileva che le popolazioni dell'Europa settentrionale ed occidentale, dei Pirenei, delle Alpi e dei Carpazi presentano esclusivamente cariotipi diploidi, mentre i taxa balcanici e mediterranei sono sia diploidi che tetraploidi. La definizione delle unità tassonomiche dell'aggregato sia in base ai caratteri morfologici sia in base a quelli cariologici è ancora molto critica. Secondo Favarger (1967), la subsp. *verna* sarebbe un taxon diploide, mentre la subsp. *collina* tetraploide. Gadella & Kliphuis (1972) hanno messo in discussione questa ipotesi e, in base a caratteri morfologici, hanno ascritto alla subsp. *collina* esemplari diploidi ($2n = 24$) raccolti in Macedonia (Sar Planina).

Il cariotipo delle popolazioni di *M. verna* del comprensorio minerario di Cave del Predil è $2n = 24$ con 9 coppie di cromosomi metacentrici e 3 coppie di cromosomi submetacentrici (Fig. 2b). La lunghezza dei cromosomi varia da 1,1 a 1,9 μm . La formula cromosomica è la seguente $2n = 2x = 24: 18m + 6sm$. I cromosomi sono piccoli e in prevalenza metacentrici.

Esemplari raccolti a Cave del Predil sono stati identificati come subsp. *collina* (Neilr.) Halliday da Pignatti (1974). Halliday (1993) riporta però per questa sottospecie un numero cromosomico $2n = 4x = 48$. Dvořáková (1985) eleva questo taxon tetraploide al livello di specie con il binomio *M. glaucina*. Lo stesso autore (1991) riporta per i Balcani *M. orthophylla*, specie diploide ($2n = 24$) affine a *M. glaucina*, nel cui gruppo andrebbero incluse pure popolazioni su serpentini della Serbia occidentale.

Ernst (1965), in un rilievo fitosociologico eseguito nell'area di Cave del Predil, identifica le popolazioni di quest'area come appartenenti alla subsp. *hercynica* (Willk.) O. Schwarz, che caratterizza le fitocenosi di stazioni minerarie della regione centroeuropea. Secondo Melzer (1973), allo stato attuale delle conoscenze, non è possibile l'identificazione suddetta.

In questo lavoro, viste le succitate diverse ipotesi di delimitazione dei taxa, rimane valida solamente l'inclusione delle popolazioni indagate nell'aggregato (*sensu* Heywood, 1963) di *Minuartia verna*. Lo studio morfologico necessario per una identificazione tassonomica di tali popolazioni è oggetto di ulteriori ricerche.

Thlaspi cepaeifolium subsp. *cepaefolium* (Fig. 2c)

Numero cromosomico: $2n=14$.

Exsiccatum: Cave del Predil (UD), 1200 m, lg. T. Cusma Velari, 14.10.1981.

In Clapham & Akeroyd (1993) *T. rotundifolium* (L.) Gaudin subsp. *cepaefolium* (Wulfen) Rouy et Fouc. viene elevato al rango di specie, mentre *T. rotundifolium* (L.) Gaudin è considerato una sua sottospecie.

T. cepaeifolium subsp. *cepaefolium* è un endemismo limitato alle popolazioni che colonizzano i suoli calaminari dell'area di Cave del Predil e che forma popolazioni eterotopiche lungo il greto del Torrente Slizza (Gailitz), che

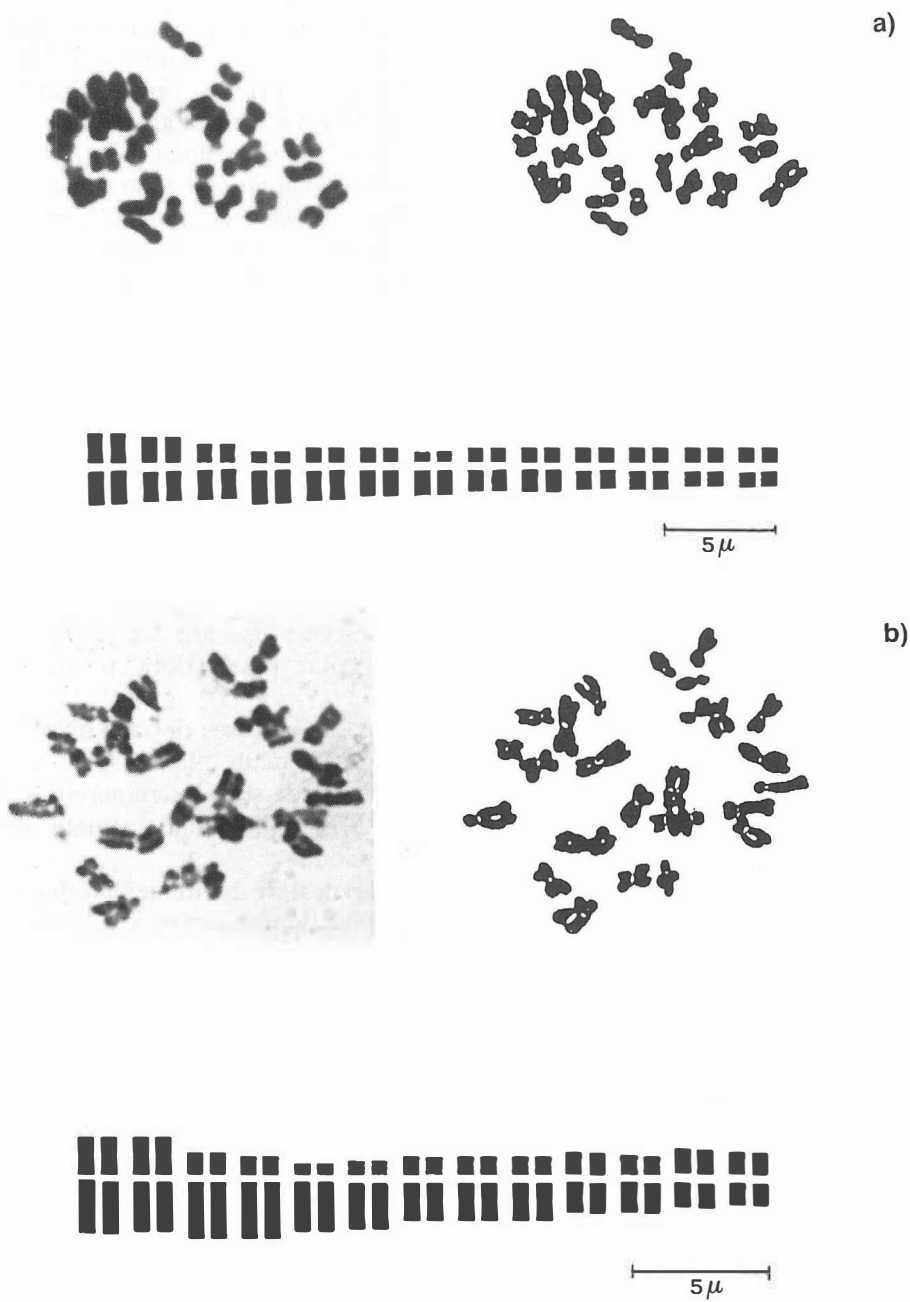


Fig. 3 - Cariotipo ed idiogramma di: a) *Viola tricolor* subsp. *subalpina*; b) *Viola tricolor* subsp. *subalpina* var. *raiblensis*.

raccoglie le acque provenienti dal comprensorio minerario di Cave del Predil, sia in Italia che in Austria (Maglern, Carinzia) (Polatschek, 1972). Questa sottospecie è stata riportata anche per numerose stazioni delle Alpi meridionali (Markgraf, 1959-1963; Mayer, 1960). Però, secondo Polatschek (1966) e Melzer (1973), solo le popolazioni del *locus classicus* si differenzerebbero nettamente dalla subsp. *rotundifolium*, mentre tutte le altre popolazioni segnalate per le Alpi meridionali sarebbero solo forme diverse della subsp. *rotundifolium*.

Polatschek (1972) riporta per *T. cepaeifolium* s. str. un numero cromosomico $2n = 14$ ($x = 7$) determinato su materiale proveniente dalla stazione eterotopica di Maglern (Carinzia, Austria). Questo valore concorda con quello riportato da Manton (1932) determinato su piante in coltura nell'Orto Botanico di Kew di provenienza ignota.

Gli esemplari delle popolazioni di Cave del Predil, *locus classicus* di questa specie, sono stati esaminati cariologicamente per la prima volta. Il cariotipo è costituito da 7 coppie di cromosomi metacentrici, di cui due in senso stretto (Fig. 2c). La lunghezza dei cromosomi varia da 0,85 a 2,0 μm . La formula cromosomica è la seguente: $2n = 2x = 14: 4M + 10m$.

Analisi dell'asimmetria del cariotipo

Per quanto concerne l'asimmetria del cariotipo, la Tab. 1 riporta per ogni taxon la categoria di appartenenza (AS) secondo il metodo di Stebbins (1971). La Fig. 4 mostra la dispersione delle specie indagate secondo gli indici di asimmetria di Romero Zarco (1986).

Si nota che con entrambi i metodi si possono distinguere quattro gruppi con diverso grado di asimmetria:

- 1) *Viola tricolor* subsp. *subalpina* var. *raiblensis*;
- 2) *Alyssum wulfenianum*, *Minuartia verna*;
- 3) *Biscutella laevigata*, *Erysimum sylvestre*, *Viola tricolor* subsp. *subalpina*;
- 4) *Thlaspi cepaeifolium*.

I risultati più interessanti dell'analisi dell'asimmetria dei cariotipi riguardano *Viola tricolor* subsp. *subalpina* var. *raiblensis* e *Thlaspi cepaeifolium*. Secondo Levitsky (1931) e Stebbins (1971), nelle stirpi affini il cariotipo più simmetrico è più primitivo e quello più asimmetrico più derivato. In base a queste considerazioni, i taxa succitati possono venir interpretati nel modo seguente:

- a) *Viola tricolor* subsp. *subalpina* var. *raiblensis*, che presenta un notevole aumento del grado di asimmetria (Tab. 1, Fig. 3 e 4) rispetto al taxon tipico corrispondente, potrebbe esser considerata un neoendemismo dei suoli calaminari.

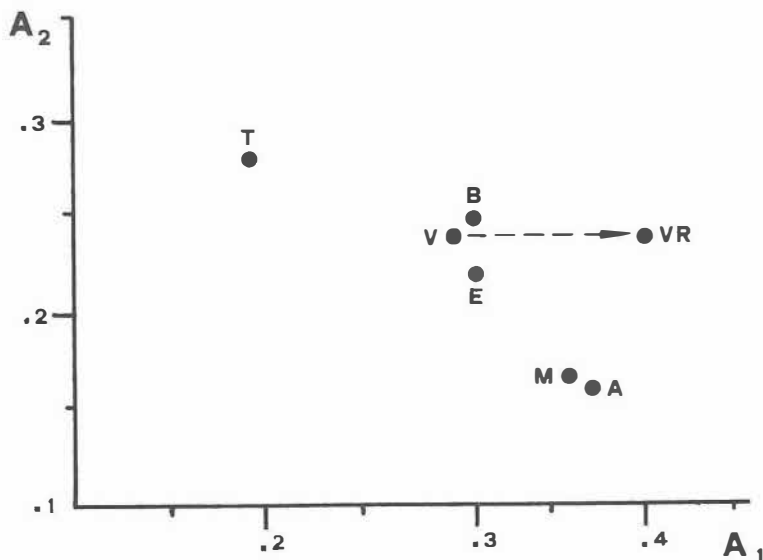


Fig. 4 - Diagramma di dispersione dell'asimmetria dei cariotipi. A_1 = indice di asimmetria intracromosomale; A_2 = indice di asimmetria intercromosomale. A: *Alyssum wulfenianum*; B: *Biscutella laevigata* subsp. *laevigata*; D: *Dianthus sylvestris*; E: *Erysimum sylvestre*; M: *Minuartia verna*; T: *Thlaspi cepaeifolium*; V: *Viola tricolor* subsp. *subalpina*; VR: *Viola tricolor* subsp. *subalpina* var. *raiblensis*. La freccia tratteggiata indica l'incremento dell'asimmetria da V a VR. (Spiegaz. nel testo).

b) *Thlaspi cepaeifolium*, che possiede un complemento cromosomico poco asimmetrico, potrebbe venir interpretato, dal punto di vista cariologico, un paleoendemismo.

Conclusioni

I risultati ottenuti con l'analisi cariologica hanno portato un notevole contributo alla tassonomia dei taxa più critici che colonizzano i suoli calaminari di Cave del Predil ed hanno generato varie ipotesi di lavoro per ulteriori studi di carattere morfologico. Difatti, le analisi cariologiche su popolazioni di taxa critici e colonizzatori di substrati che influenzano notevolmente il loro fenotipo, danno un contributo notevole per la delimitazione sistematica delle stirpi e forniscono ipotesi sulla loro origine.

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